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Methods for Assessing Exposure to Chemical Substances

Volume 4

Methods for Enumerating and Characterizing Populations Exposed to Chemical Substances

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METHODS FOR ASSESSING EXPOSURE TO CHEMICAL SUBSTANCES

Volume 4

Methods for Enumerating and Characterizing Populations Exposed to Chemical Substances

by

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U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF PESTICIDES AND TOXIC SUBSTANCES
WASHINGTON, DC 20460

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FOREWORD

This document is one of a series of volumes, developed for the U.S. Environmental Protection Agency (EPA), Office of Toxic Substances (OTS), that provides methods and information useful for assessing exposure to chemical substances. The methods described in these volumes have been identified by EPA-OTS as having utility in exposure assessments on existing and new chemicals in the OTS program. These methods are not necessarily the only methods used by OTS, because the state-of-the-art in exposure assessment is changing rapidly, as is the availability of methods and tools. There is no single correct approach to performing an exposure assessment, and the methods in these volumes are accordingly discussed only as options to be considered, rather than as rigid procedures.

Perhaps more important than the optional methods presented in these volumes is the general information catalogued. These documents contain a great deal of non-chemical-specific data which can be used for many types of exposure assessments. This information is presented along with the methods in individual volumes and appendices. As a set, these volumes should be thought of as a catalog of information useful in exposure assessment, and not as a "how-to" cookbook on the subject.

The definition, background, and discussion of planning exposure assessments are discussed in the introductory volume of the series (Volume 1). Each subsequent volume addresses only one general exposure setting. Consult Volume 1 for guidance on the proper use and interrelations of the various volumes and on the planning and integration of an entire assessment.

The titles of the nine basic volumes are as follows:

Volume 1	Methods for Assessing Exposure to Chemical Substances (EPA 560/5-85-001)
Volume 2	Methods for Assessing Exposure to Chemical Substances in the Ambient Environment (EPA 560/5-85-002)
Volume 3	Methods for Assessing Exposure from Disposal of Chemical Substances (EPA 560/5-85-003)
Volume 4	Methods for Enumerating and Characterizing Populations Exposed to Chemical Substances (EPA 560/5-85-004)
Volume 5	Methods for Assessing Exposure to Chemical Substances in Drinking Water (EPA 560/5-85-005)

Volume 6	Methods for Assessing Occupational Exposure to Chemical Substances (EPA 560/5-85-006)
Volume 7	Methods for Assessing Consumer Exposure to Chemical Substances (EPA 560/5-85-007)
Volume 8	Methods for Assessing Environmental Pathways of Food Contamination (EPA 560/5-85-008)
Volume 9	Methods for Assessing Exposure to Chemical Substances Resulting from Transportation-Related Spills (EPA 560/5-85-009)

Because exposure assessment is a rapidly developing field, its methods and analytical tools are quite dynamic. EPA-OTS intends to issue periodic supplements for Volumes 2 through 9 to describe significant improvements and updates for the existing information, as well as adding short monographs to the series on specific areas of interest. The first four of these monographs are as follows:

Volume 10	Methods for Estimating Uncertainties in Exposure Assessments (EPA 560/5-85-014)
Volume 11	Methods for Estimating the Migration of Chemical Substances from Solid Matrices (EPA 560/5-85-015)
Volume 12	Methods for Estimating the Concentration of Chemical Substances in Indoor Air (EPA 560/5-85-016)
Volume 13	Methods for Estimating Retention of Liquids on Hands (EPA 560/5-85-017)

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1. INTRODUCTION

This volume is the fourth in a series of nine volumes presenting methods for assessing exposures to chemical substances; the reports are being developed for the U.S. Environmental Protection Agency (EPA), Office of Toxic Substances (OTS). This volume presents methods and supporting information for enumerating and characterizing populations exposed to chemical substances in each of the EPA-OTS defined exposure categories. The purpose and scope of this report, the report organization, and the methodological framework are discussed in the following subsections.

1.1 Purpose and Scope

This document and the methods that it contains have been prepared to aid in overcoming one of the major difficulties encountered in the preparation of exposure assessments for individual chemical substances: the enumeration and characterization of specific populations exposed to chemical substances. Each of the seven categories of an exposure assessment has certain populations associated with it, and each population has further subpopulations that vary with respect to the concentrations to which they are exposed and the frequency and duration of exposure. While it has often been possible to identify exposed populations from monitoring or release data, it has rarely been possible to estimate sizes of specific subpopulations. The purpose of this report, therefore, is to catalog pertinent information, data bases, and tools, and to provide a systematic approach or methods whereby the population exposed to a given chemical substance in each of the exposure categories can be enumerated and characterized according to age and sex at any desired level of detail.

1.2 Report Organization

The data sources and methods to enumerate and characterize exposed populations in each of the exposure categories are specific to that exposure category. This report, therefore, is divided into separate sections according to the category of exposed populations as follows:

- Section 2 - Populations Exposed to Chemical Substances in the Ambient Environment
- Section 3 - Populations Exposed to Chemical Substances in the Occupational Environment
- Section 4 - Populations Exposed to Chemical Substances via the Ingestion of Food

- Section 5 - Populations Exposed to Chemical Substances via the Use of Consumer Products
- Section 6 - Populations Exposed to Chemical Substances via the Ingestion of Drinking Water.

Exposures resulting from the disposal and transportation related spills of chemical substances are subsets of exposures occurring in the ambient environment. Populations exposed to chemical substances in these categories are identified either geographically or by occupation. Section 2 of this report covers the geographic enumeration and characterization of exposed populations, while Section 3 covers the enumeration and characterization of occupationally exposed populations. Finally, demonstrations of the methods contained in each section of this report are presented as example population problems in the Appendix.

1.3 Framework of Methods

The framework for enumerating and characterizing exposed populations is the same for each of the sections and comprises three stages. These stages are:

1. The identification of the exposed population.

2. The enumeration of the exposed population.

3. The characterization of the exposed population according to age and sex.

Figure 1 is a flow diagram of the three-stage framework. The following paragraphs briefly describe each stage; detailed information is provided in each of the sections of this report.

The first stage, the identification of exposed populations, is a function of the chemical and physical properties, sources of environmental release (i.e., manufacturing, processing, distribution, use, and disposal), and environmental transport and transformation of a chemical substance. Identification and evaluation of these data will indicate the media (i.e., air, water, soil), exposure route (inhalation, ingestion, dermal absorption), exposure category or scenario (e.g., ambient, occupational, drinking water), and the activities that lead to exposure or the microenvironments where exposure occurs. Information on identifying exposed populations is contained in Volumes 2 through 9 of this exposure assessment methods report series.. This report only briefly describes the procedures for identifying exposed populations.

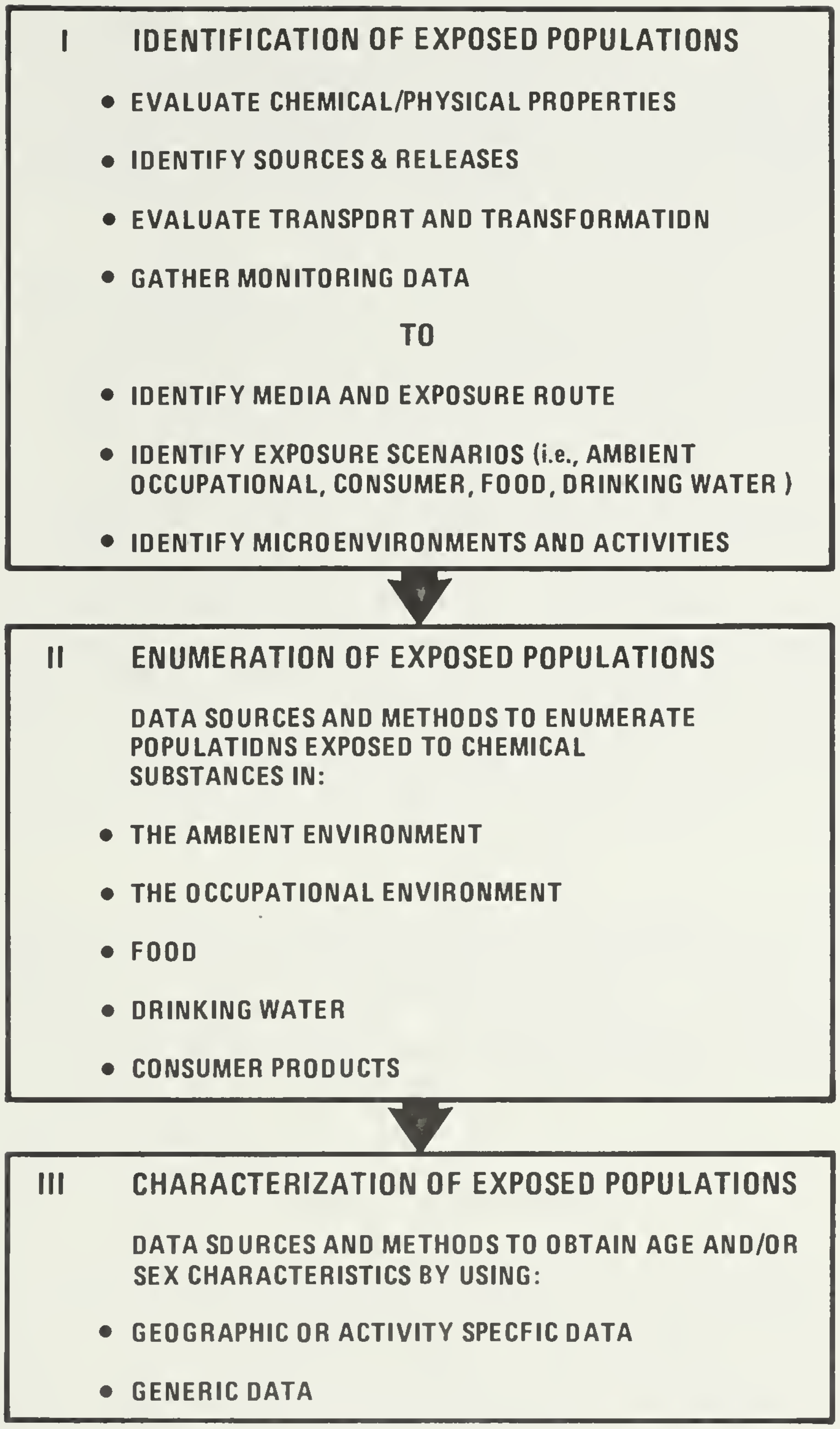

I IDENTIFICATION OF EXPOSED POPULATIONS
• EVALUATE CHEMICAL/PHYSICAL PROPERTIES
• IDENTIFY SOURCES & RELEASES
• EVALUATE TRANSPORT AND TRANSFORMATION
• GATHER MONITORING DATA
TO
• IDENTIFY MEDIA AND EXPOSURE ROUTE
• IDENTIFY EXPOSURE SCENARIOS (i.e., AMBIENT OCCUPATIONAL, CONSUMER, FOOD, DRINKING WATER)
• IDENTIFY MICROENVIRONMENTS AND ACTIVITIES
II ENUMERATION OF EXPOSED POPULATIONS
DATA SOURCES AND METHODS TO ENUMERATE POPULATIONS EXPOSED TO CHEMICAL SUBSTANCES IN:
• THE AMBIENT ENVIRONMENT
• THE OCCUPATIONAL ENVIRONMENT
• FOOD
• DRINKING WATER
• CONSUMER PRODUCTS
III CHARACTERIZATION OF EXPOSED POPULATIONS
DATA SOURCES AND METHODS TO OBTAIN AGE AND/OR SEX CHARACTERISTICS BY USING:
• GEOGRAPHIC OR ACTIVITY SPECFIC DATA
• GENERIC DATA

Figure 1. Three-stage Framework for Identifying, Enumerating, and Characterizing Populations Exposed to Chemical Substances

The second stage involves the use of various data sources, computerized data bases, and generic information to enumerate exposed populations. In the appropriate exposure category sections of this report, data sources are discussed, including any limitations; the responsible agencies or individuals who must be contacted to obtain the required information are also listed. Methods utilizing the various data sources are presented in a step-by-step fashion in each section so that the investigator or exposure assessment team can enumerate exposed populations efficiently.

The final stage describes the data sources and procedures to be used to characterize the exposed population. Characterization of the exposed population involves determining the numbers of individuals in particular age and sex classes. The age and sex of the exposed population affect the physiological parameters that determine exposure (i.e., breathing rate, body weight, skin surface area) and identify sensitive subpopulations (e.g., children, women of childbearing age). Detailed exposure assessments may require that populations be described by age and sex distribution. The procedures presented for this stage in each of the exposure category sections direct the investigator or assessment team in the use of geographic data, activity-specific data, or generic data on age and sex distributions to characterize exposed populations.

2. POPULATIONS EXPOSED TO CHEMICAL SUBSTANCES IN THE AMBIENT ENVIRONMENT

2.1 Introduction

This section presents methods for enumerating and characterizing populations exposed to chemical substances in the ambient environment. The methods described are applicable to populations exposed as a result of industrial effluents, non-point or area sources, natural sources, disposal related releases, consumer related releases, spills from transportation or storage activities, and unknown sources.

Figure 2 is a flow diagram of the three-stage framework for enumerating populations exposed to chemical substances in the ambient environment. Included in the diagram are some of the major data sources used in the three stages.

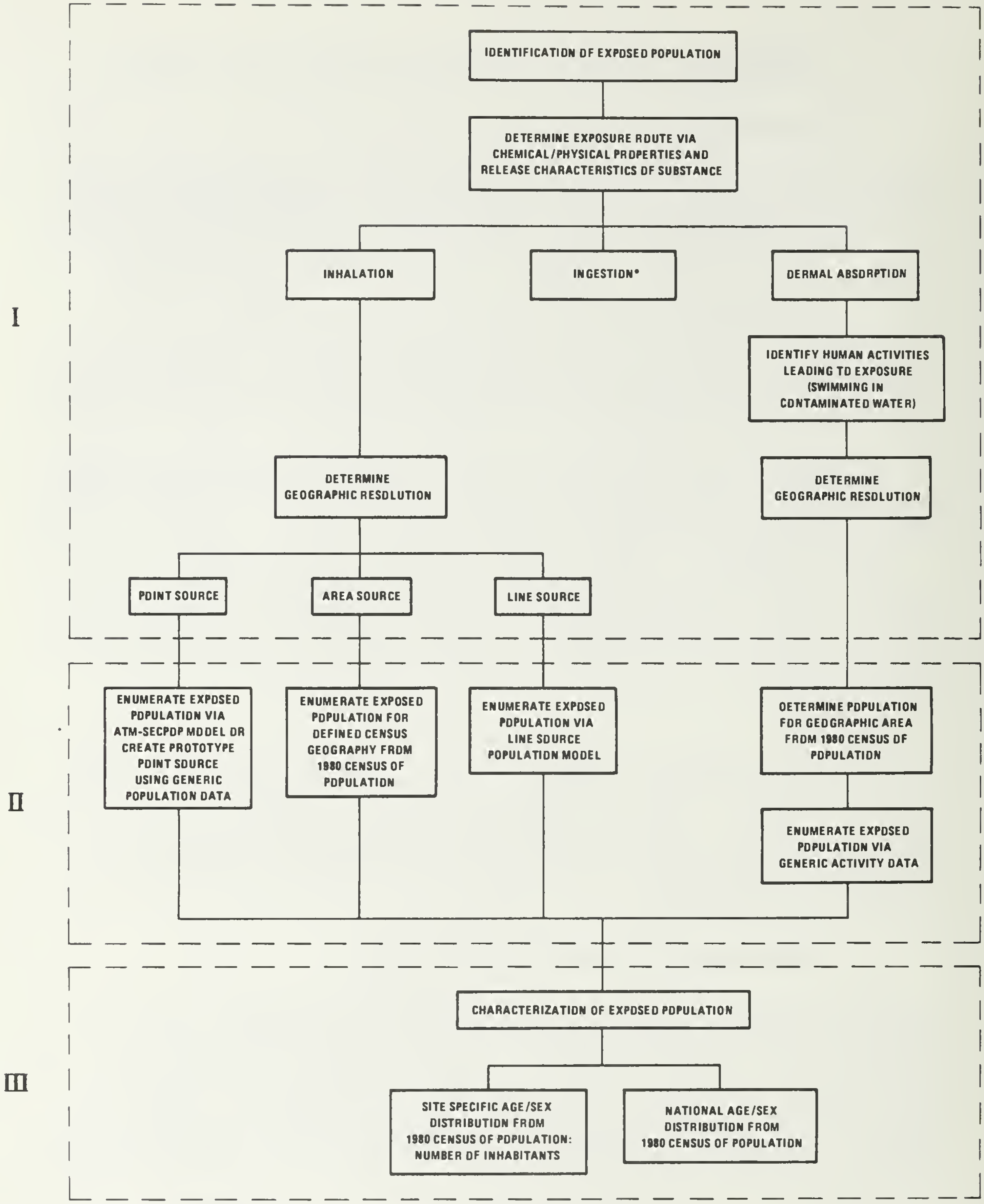
The identification of exposed populations is discussed only briefly in this section (Subsection 2.2); the ambient exposure assessment methods report (Volume 2) describes the process in detail.

The enumeration of the exposed population principally relies on population data collected by the Bureau of the Census, particularly the decennial Census of Population. The most recently conducted Census, the data publication form and document titles, and the use of census data in exposure assessment population studies are discussed in detail in Subsection 2.3.

The age and sex of the exposed population affect the physiological parameters that determine exposure (e.g., breathing rate, skin surface area) and identify sensitive subpopulations (e.g., women of child-bearing age, the elderly). Detailed exposure assessments may require that populations be described by age and sex distribution. Subsection 2.4 discusses the data sources and procedures to characterize populations by age and sex distribution.

2.2 Identification of Exposed Populations

Populations potentially exposed to a chemical substance in the ambient environment are identified through an evaluation of the substance's sources, its behavior in the environment, and applicable monitoring data. Subpopulations may be further defined by their participation in specific activities leading to exposure. Method 2-1 summarizes the steps involved in identifying populations exposed to chemical substances in the ambient environment. Volume 2 of this series describes the requisite data in detail.


IDENTIFICATION OF EXPOSED POPULATION
DETERMINE EXPOSURE ROUTE VIA CHEMICAL/PHYSICAL PROPERTIES AND RELEASE CHARACTERISTICS OF SUBSTANCE
INHALATION
INGESTION*
DERMAL ABSORPTION
I
IDENTIFY HUMAN ACTIVITIES LEADING TO EXPOSURE (SWIMMING IN CONTAMINATED WATER)
DETERMINE GEOGRAPHIC RESOLUTION
DETERMINE GEOGRAPHIC RESOLUTION
POINT SOURCE
AREA SOURCE
LINE SOURCE
ENUMERATE EXPOSED POPULATION VIA ATM-SECPOP MODEL OR CREATE PROTOTYPE POINT SOURCE USING GENERIC POPULATION DATA
ENUMERATE EXPOSED POPULATION FOR DEFINED CENSUS GEOGRAPHY FROM 1980 CENSUS OF POPULATION
ENUMERATE EXPOSED POPULATION VIA LINE SOURCE POPULATION MODEL
DETERMINE POPULATION FOR GEOGRAPHIC AREA FROM 1980 CENSUS OF POPULATION
II
ENUMERATE EXPOSED POPULATION VIA GENERIC ACTIVITY DATA
CHARACTERIZATION OF EXPOSED POPULATION
III
SITE SPECIFIC AGE/SEX DISTRIBUTION FROM 1980 CENSUS OF POPULATION: NUMBER OF INHABITANTS
NATIONAL AGE/SEX DISTRIBUTION FROM 1980 CENSUS OF POPULATION

*NOT CONSIDERED IN THIS METHOD
(SEE VOLUME 5 – METHODS FOR ASSESSING EXPOSURE TO CHEMICAL SUBSTANCES IN DRINKING WATER)

Figure 2. Three-stage Framework for Enumerating and Characterizing Populations Exposed to Chemical Substances in the Ambient Environment

Method 2-1. General Procedure for Identifying Populations Exposed to Chemical Substances in the Ambient Environment

Step 1 Identify the locations of chemical release into the environment; define each release to the atmosphere as a point, area, or line source. Using monitoring data and/or environmental fate information, identify the geographic locales and media of concern (air, water, land). Volume 2 of this series catalogs data bases, information sources, and tools that will aid in this process.

Step 2 For each medium of interest, evaluate the significance of exposure routes:

- Air - inhalation
- Water - dermal contact
- Land - dermal contact

Step 3 Identify exposed populations by listing significant pathways:

- Persons breathing ambient air contaminated by atmospheric point, area, or line sources.

- Persons swimming in contaminated surface waters.

- Non-human populations of ecological or economic importance residing in the locale and media of concern.

- Other populations not specifically addressed in this volume (e.g., children swallowing or chewing objects or playing in soil contaminated with fallout of particulates consisting of or containing the chemical substance).

Exposed populations are initially identified as those near sources of the substance; modeling and monitoring provide the geographic definition of "near" by defining the levels of exposure in the environment at a given point or general location. Knowledge of a substance's physical and chemical properties, emission characteristics, and environmental transport and transformation helps to identify the physical state of the chemical and the media (e.g., air, water) into which it is released and to which it will partition. The physical state and media in turn determine the potential exposure routes: inhalation, ingestion, and dermal contact.

In order to enumerate exposed populations, identification must be refined beyond the determination of exposure route by considering the geographic locations where the chemical is released and the activities in the ambient environment that result in exposure. Inhalation exposures may result from proximity to:

- Point sources - known locations of emissions identifiable by geographic coordinates (e.g., industrial discharges, disposal sites).
- Area sources - sources related to chemical use or incidental emission defined by broad geographic boundaries (e.g., urban areas as a source of automotive exhaust).
- Line sources - sources of chemical emission, usually assumed to be at a constant rate, that are mobile and move along a pathway or line such as a road, rail, or river.

Since breathing is a constant activity, populations exposed via inhalation are defined only by the sources listed above.

Dermal exposure to a chemical substance may result from contact with ambient air, water, or soil. Dermal exposure to airborne contaminants is likely to be insignificant in comparison to inhalation exposure. The most important exposure pathways for the dermal route are probably swimming in surface waters and contacting soil during work or play.

Only the most significant and common pathways of exposure are considered in this report. There are numerous other exposure pathways in the ambient environment that are not dealt with in this report (e.g., ingestion of contaminated soil by children). Identification of these pathways and the exposed populations must be addressed within individual exposure assessments. The data bases, information sources, and tools discussed in this report will aid in this process.

2.3 Methods for the Enumeration of Exposed Populations

This section discusses the data sources and recommended procedures for enumerating populations exposed to chemical substances in the ambient environment. Because populations exposed to chemical substances in the ambient environment are defined geographically and since the Census of Population is the major geographic population data base, the first subsection (2.3.1) is devoted to its discussion. The methods developed for the enumeration of exposed populations are subsequently discussed according to inhalation exposure in Subsection 2.3.2 and dermal exposure in Subsection 2.3.3.

2.3.1 Census of Population

The U.S. Census, conducted once every decade, determines the size, distribution, and demographic characteristics of the population. The most recent Census was conducted in 1980 and is divided into two categories: (1) complete count data for the entire U.S. population (short form) and (2) more detailed population, social, and economic characteristics for 20 percent of the U.S. population (long form). The data collected in each of these categories are listed in Table 1.

The data collected in the Census are organized according to geographic areas in the U.S. as illustrated in Figure 3 and within geographic areas according to census-defined statistical areas and government units as listed in Table 2. Figure 4 illustrates the geographic organization of the major census statistical areas (i.e., Standard Metropolitan Statistical Areas (SMSAs), urbanized areas, and urban and rural areas). The detailed breakdown of census geography is illustrated in Figures 5 and 6. Population data, therefore, are available within SMSAs to the level of the Block and in non-SMSAs to the level of the Enumeration District (ED).

Census geography and the population data available for each geographic category are extremely important throughout this methodology. In this section, and all sections of the methodology, census geography will be used as consistently as possible. It should be noted that many organizations report population data according to what appears to be census geographic categories (e.g., "urban" population, "rural" population). Upon further investigation, however, sample design and data presentation may not strictly follow the census definition of geographic categories. When using population data not reported by the Bureau of the census, therefore, the investigator should carefully review the geographic categories of data presentation for consistency with the census classifications.

Table 1. Population Subject Items Included in the 1980 Census

100% Items	Sample items (20% sample or 1 out of 6 households)
● Household relationship	● School enrollment
● Sex	● Educational attainment
● Race	● State or foreign country of birth
● Age	● Citizenship and year of immigration
● Marital status	● Current language and English proficiency
● Spanish/Hispanic origin or descent	● Ancestry
	● Place of residence five years ago
	● Activity five years ago
	● Veteran status and period of service
	● Presence of disability or handicap
	● Children ever born
	● Marital history
	● Employment status last week
	● Place of work
	● Travel time to work
	● Means of transportation to work
	● Number of persons in carpool
	● Year last worked
	● Industry
	● Occupation
	● Type of employment
	● Number weeks worked in 1979
	● Usual hours worked per week in 1979
	● Number weeks looking for work in 1979
	● Amount of income in 1979 by source

Source: Bureau of the Census 1979a.

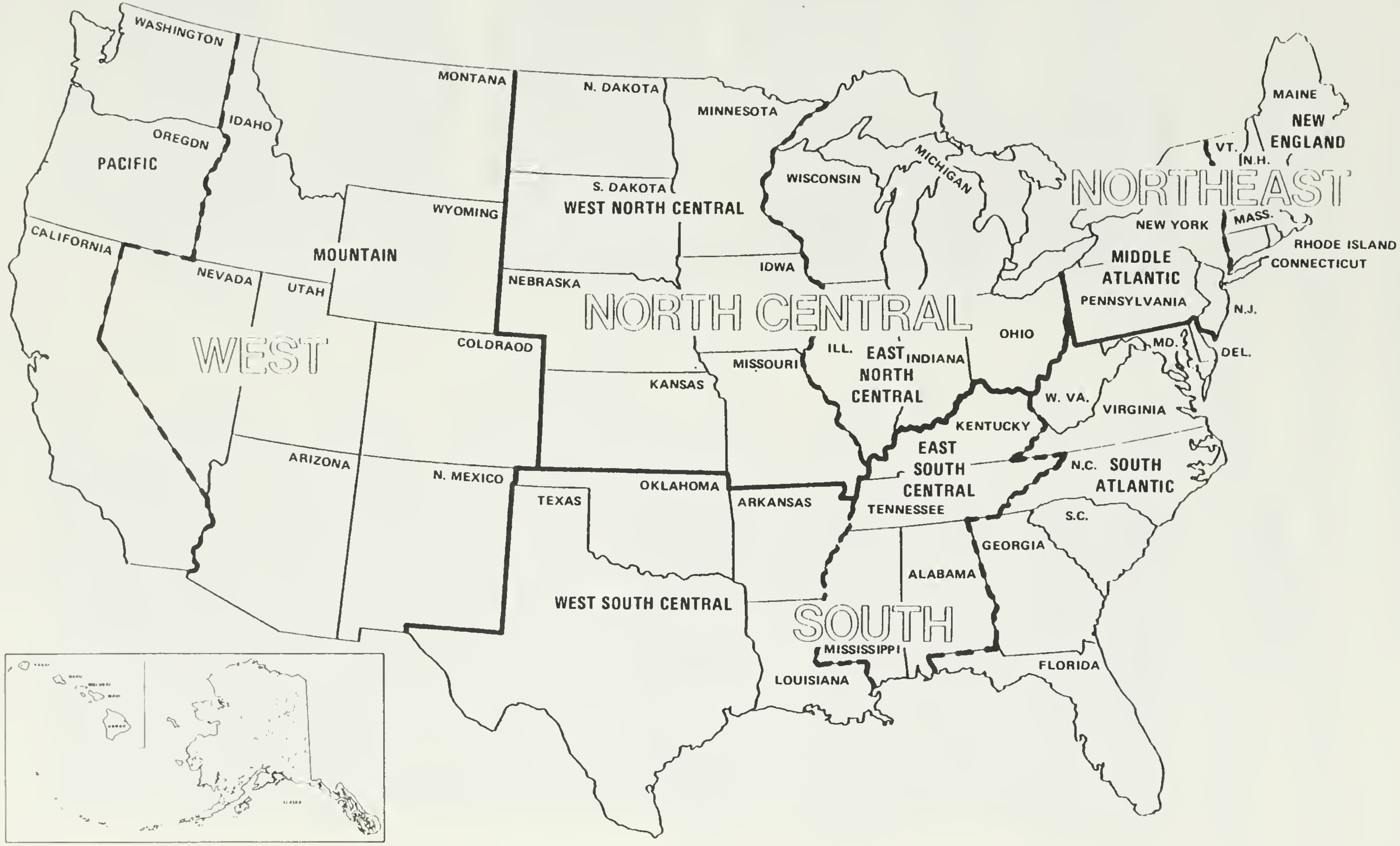

WASHINGTON
OREGDN
PACIFIC
CALIFORNIA
IDAHO
MONTANA
NEVADA
UTAH
WYOMING
MOUNTAIN
WEST
COLDRAOD
ARIZONA
N. MEXICO
N. DAKOTA
MINNESOTA
S. DAKOTA
WEST NORTH CENTRAL
NEBRASKA
IDWA
NORTH CENTRAL
KANSAS
MISSOURI
WISCONSIN
MICHIGAN
ILL.
EAST NORTH CENTRAL
INDIANA
OHIO
TEXAS
OKLAHOMA
ARKANSAS
WEST SOUTH CENTRAL
LOUISIANA
KENTUCKY
EAST SOUTH CENTRAL
TENNESSEE
MISSISSIPPI
ALABAMA
SOUTH
GEORGIA
FLORIDA
S.C.
N.C.
SOUTH ATLANTIC
VIRGINIA
W. VA.
MD.
DEL.
PENNSYLVANIA
MIDDLE ATLANTIC
NEW YORK
N.J.
NORTHEAST
MAINE
NEW ENGLAND
VT.
N.H.
MASS.
RHODE ISLAND
CONNECTICUT

Figure 3. Geographic Regions and Divisions of the United States

Table 2. Geographic Units of the Census of Population

Statistical areas	Government units
• Regions: Regions are large, geographically contiguous groups of states (with the exception of the region that includes Alaska and Hawaii). There are four regions: Northeast, North Central, South, and West (see Figure 1). • Divisions: Divisions are groups of states which are subdivisions of regions. There are nine divisions: New England, Middle Atlantic, South Atlantic, East South Central, West South Central, East North Central, West North Central, Mountain, and Pacific (see Figure 1). • Standard Metropolitan Statistical Areas (SMSAs): An SMSA is an integrated economic and social unit with a recognized large population nucleus. Generally, each SMSA consists of one or more entire counties, or county equivalents, that meet standards pertaining to population and metropolitan character. In New England, towns and cities, rather than counties, are used as the basic geographic units for defining SMSAs. In Alaska, census divisions are used to define SMSAs. Criteria used to delineate the 267 SMSAs for which data were tabulated for the 1972 Economic Censuses specified that an SMSA include at least (1) one city with 50,000 inhabitants, or more or (2) a city having a population of at least 25,000 which, with the addition of the population of contiguous places, incorporated or unincorporated, has a population density of at least 1,000 persons per square mile. Together, they must constitute, for general economic and social purposes, a single community with	• The United States • States: The 50 states are the major political units of the United States. The District of Columbia is treated as a state-equivalent. • Counties: Counties are the primary political and administrative divisions of the states. • Minor Civil Divisions (MCDs): These are the primary political and administrative subdivisions of counties; most frequently known as townships, but in some states include towns, precincts, and magisterial districts. • Census County Divisions (CCDs). In 21 states, MCDs were found to be unsuitable for presenting statistics due to area's small population size, frequent boundary changes, etc. CCDs are defined with boundaries that seldom change and can be easily located (e.g., roads, railroads, power lines, and bridges). • Places: A concentration of population, regardless of the existence of legally prescribed units, powers, or functions. In the 1970 Census, most places are incorporated as cities, towns, villages, or boroughs. – Incorporated places: These are political units incorporated as cities, boroughs (excluding Alaska and New York), villages, and towns (excluding the New England States, New York, and Wisconsin). Most incorporated places are subdivisions of the MCD or CCD in which they are

Table 2. (continued)

Statistical areas	Government units
a combined population of at least 50,000, provided that the county or counties in which the city and contiguous places are located has a total population of at least 75,000. • Central cities (of an SMSA): The largest city of an SMSA is always a central city. One or two additional cities may be added to the SMSA title and identified as central cities if: (1) the additional city or cities have a population of one-third or more of that of the largest city and a minimum population of 25,000 or (2) the additional city has at least 250,000 inhabitants. • Standard Consolidated Statistical Areas (SCSAs): Two or more contiguous SMSAs which meet certain criteria of population size, urban character, social and economic integration, and contiguity of urbanized areas. Examples are: Detroit-Ann Arbor, MI, Seattle-Tacoma, WA, San Francisco-Oakland-San Jose, CA. • Urbanized Areas (UAs): Contain a central city (or twin cities) meeting the same criteria as an SMSA, plus the surrounding closely settled incorporated and unincorporated areas which meet certain criteria of population size or density. UAs differ from SMSAs chiefly by excluding the rural portions of counties that make up the SMSAs as well as those places that are separated by rural territory from the densely populated fringe around the central city.	located, for example, a village located within and legally part of a township. However, almost 4,000 incorporated places cross MCD and/or county lines, but no incorporated places cross state lines since they are chartered under the laws of a state. There were over 18,500 incorporated places in 1970. • Unincorporated places. These are densely settled population centers without legally defined corporate limits or any other corporate powers or functions. In 1970, statistics were tabulated for each unincorporated place with 5,000 inhabitants or more if located inside an urbanized area, or with 1,000 inhabitants or more if located outside an urbanized area.

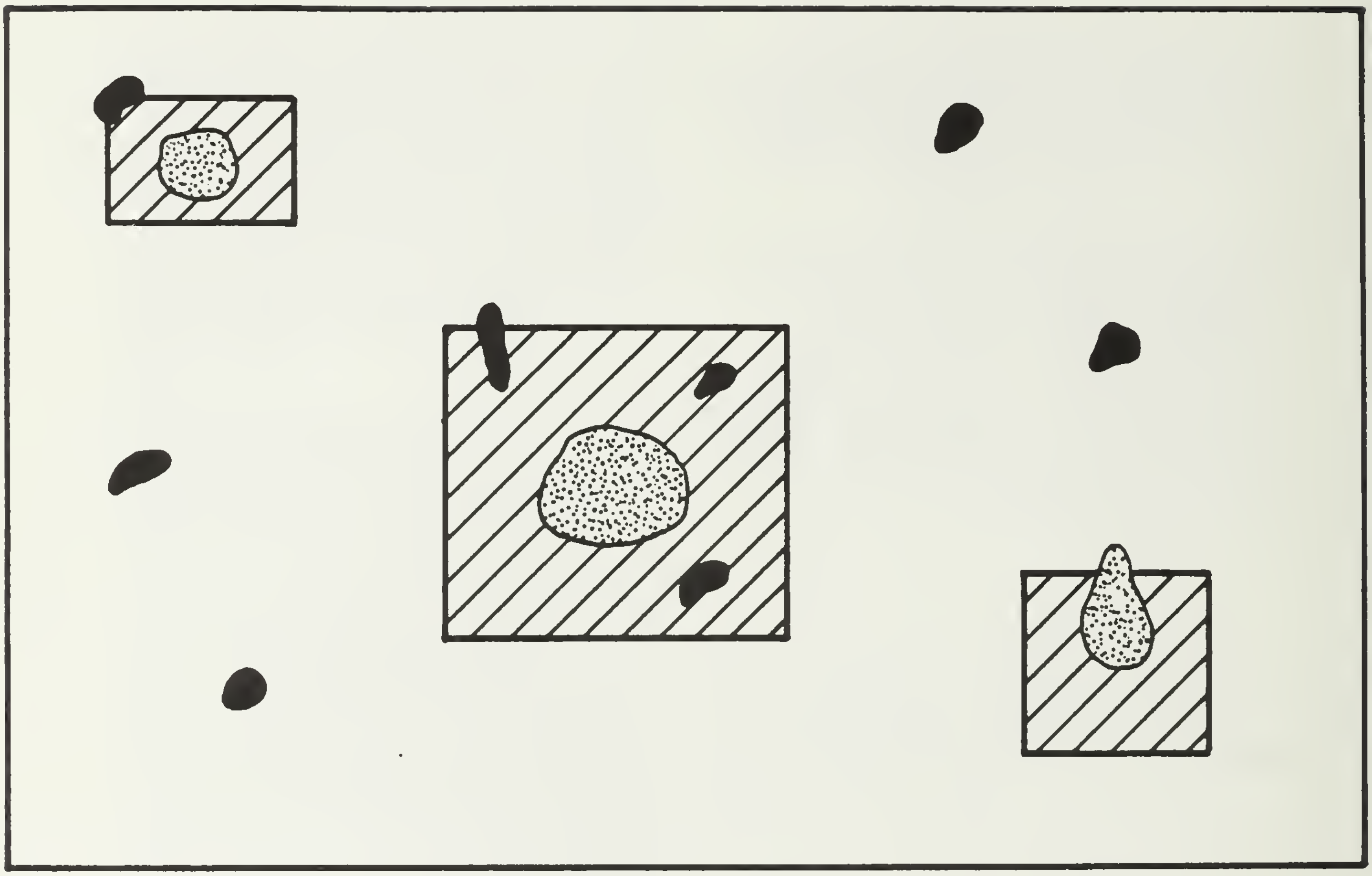
Table 2. (continued)

Statistical areas	Government units
• Urban and Rural Areas: Urban population comprises all persons living in urbanized areas and in places of 2,500 inhabitants or more outside urbanized areas. The population not classified as urban constitutes the rural population. This is divided into rural-farm (all rural households living on farms) and rural nonfarm (remaining rural population).	
• Census Designated Place (CDP): for the 1980 Census, CDPs will be used to describe densely settled population centers without legally defined limits or corporate powers. CDPs, like unincorporated places in 1970, contain a dense, city-type street pattern and ideally should have an overall population density of at least 1,000 persons per square mile. In addition, a CDP should be a community that can be identified locally by place name, having developed over the years from a small commercial area or market center, rather than encompassing a residential land subdivision, apartment development, or general urban expansion area.	
• Census Tracts: Generally, small, relatively permanent areas into which metropolitan and certain other areas are divided. An average tract contains about 4,000 residents. All SMSAs are completely tracted.	
• Enumeration Districts (EDs): Areas within census tracts, MCDs, and CCDs with an average of about 800 people or 250 housing units. EDs are generally used when block groups are not defined for an area. Together with Block Groups, the ED/BG category covers the entire U.S.	

Table 2. (continued)

Statistical areas	Government units
• Block Groups (BGs): This area is a combination of contiguous blocks having an average population of about 1,100. BGs are subdivisions of census tracts.	
• Blocks: A census block is a well-defined piece of land, bounded by streets, roads, railroad tracks, streams, or other features on the ground. Blocks do not cross census tract boundaries, but may cross other boundaries such as city limits. Blocks are the smallest areas for which census data are tabulated.	

Source: U.S. Bureau of the Census 1979b.



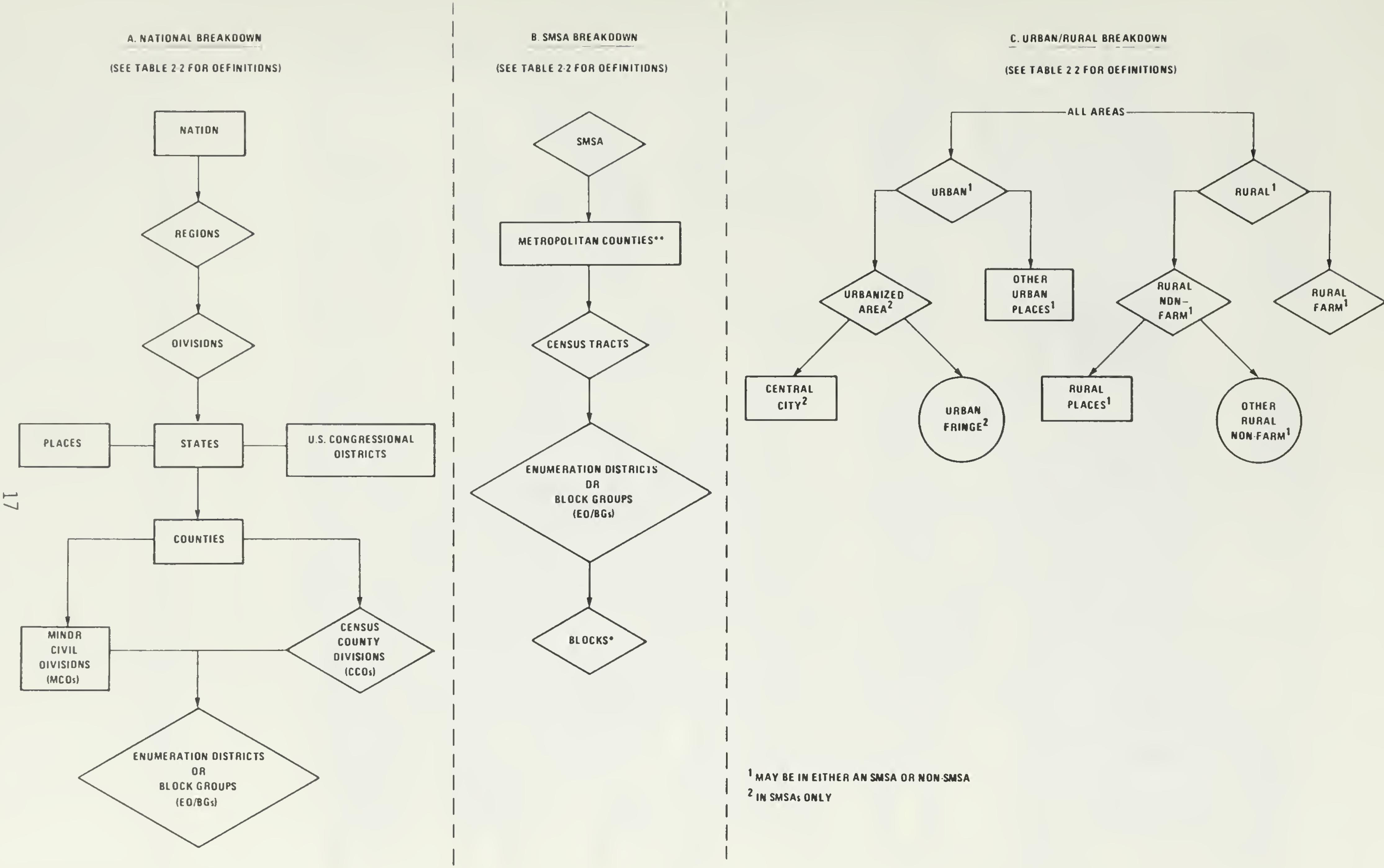
▨ = STANDARD METROPOLITAN STATISTICAL AREA (SMSA)

░ = URBANIZED AREA. CONSISTS OF CENTRAL CITY AND URBAN FRINGE (MAY IN RARE CASES EXTEND OUTSIDE OF SMSA BOUNDARY).

● = OTHER URBAN AREAS

□ = UNSHADED AREAS INSIDE OR OUTSIDE OF SMSA BOUNDARIES ARE CONSIDERED RURAL.

Figure 4. Geographic Organization of the Major Census Statistical Categories



A. NATIONAL BREAKDOWN

(SEE TABLE 2 2 FOR DEFINITIONS)

B. SMSA BREAKDOWN

(SEE TABLE 2-2 FOR DEFINITIONS)

C. URBAN/RURAL BREAKDOWN

(SEE TABLE 2 2 FOR DEFINITIONS)

NATION
REGIONS
DIVISIONS
PLACES
STATES
U.S. CONGRESSIONAL DISTRICTS
COUNTIES
MINOR CIVIL DIVISIONS (MCDs)
CENSUS COUNTY DIVISIONS (CCDs)
ENUMERATION DISTRICTS OR BLOCK GROUPS (ED/BGs)
SMSA
METROPOLITAN COUNTIES**
CENSUS TRACTS
ENUMERATION DISTRICTS OR BLOCK GROUPS (ED/BGs)
BLOCKS*
ALL AREAS
URBAN¹
RURAL¹
URBANIZED AREA²
OTHER URBAN PLACES¹
RURAL NON-FARM¹
RURAL FARM¹
CENTRAL CITY²
URBAN FRINGE²
RURAL PLACES¹
OTHER RURAL NON-FARM¹

[1] MAY BE IN EITHER AN SMSA OR NON-SMSA

[2] IN SMSAs ONLY

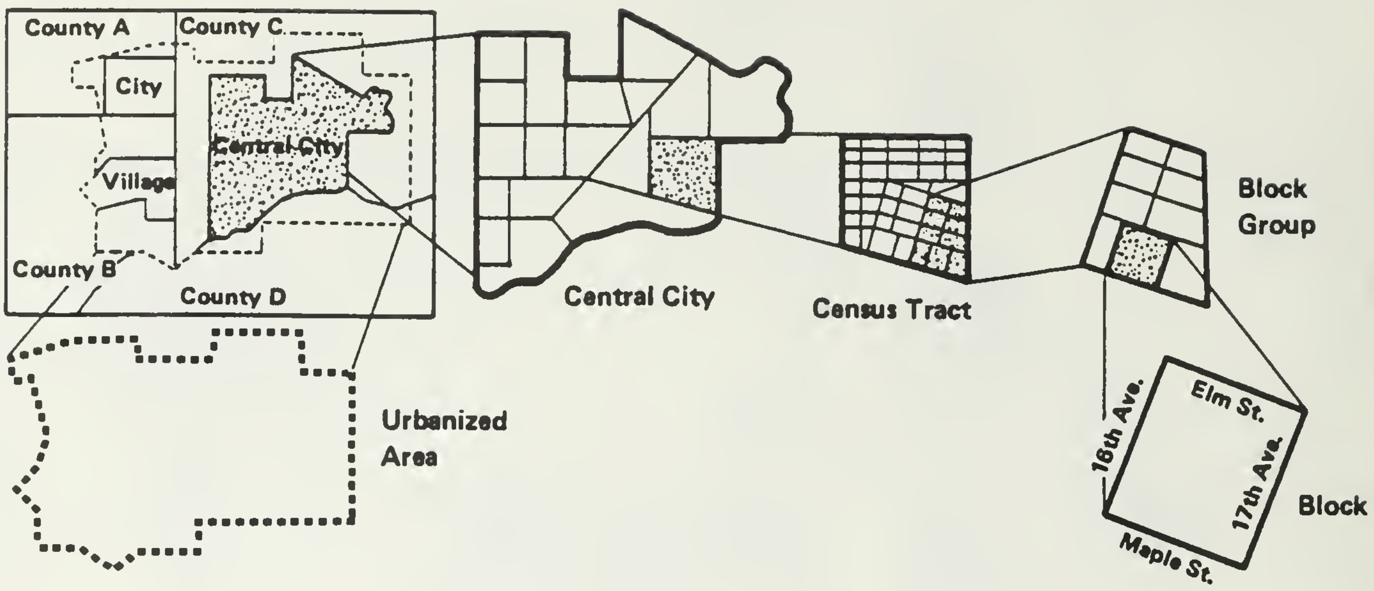
*BLOCKS COVER ONLY THE URBANIZED AREA OF AN SMSA

**IN NEW ENGLAND, METROPOLITAN TOWNS (MCDs) AND CITIES REPLACE COUNTIES AS COMPONENTS OF SMSA's

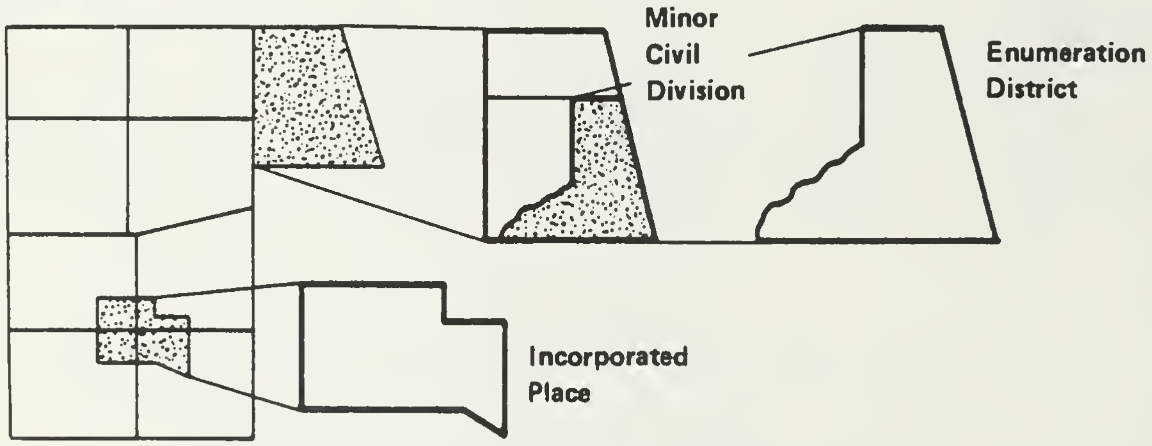
SOURCE: BUREAU OF THE CENSUS 1979b.

Figure 5. Breakdown of Census Geography

SMSA / Metropolitan Counties


County A
County C
City
Central City
Village
County B
County D
Urbanized Area
Central City
Census Tract
Block Group
Elm St.
16th Ave.
17th Ave.
Maple St.
Block

Nonmetropolitan County


Minor Civil Division
Enumeration District
Incorporated Place

SOURCE: BUREAU OF THE CENSUS 1980a.

Figure 6. Census Geography For Metropolitan and Nonmetropolitan Counties

The data collected in the 1980 Census of Population are in the process of being released by the Census Bureau. The data are available both in printed documents and on computer tape. Table 3 lists the printed documents that are or will be available in the near future from the Census Bureau.

The Number of Inhabitants (Series PC80-1-A) and General Population Characteristics (Series PC80-1-B) are the most useful reports for obtaining population data down to the town or township level. Both documents are available according to state, and each includes a separate U.S. summary document. Number of Inhabitants provides only population counts (i.e., no age and sex or other demographic data). General Population Characteristics provides population counts by sex and by age and sex as well as the other demographic data listed in Table 3 to the same geographic resolution as Number of Inhabitants.

Detailed counts and characteristics within Standard Metropolitan Statistical Areas (SMSAs) are available in Census Tracts (Series PHC80-2) and Block Statistics (PHC80-1). Census Tracts will be issued with accompanying maps (for tract identification) and will contain detailed characteristics of the population (e.g., age, sex, race, education).

Census Tracts is available by the photocopied page, and by mid-1983 it will be available on microfiche by SMSA (which is less expensive) and on computer tape. If further resolution or detail is required, Block Statistics may be consulted. This has been issued in microfiche only with accompanying maps both in print and on microfiche. Block Statistics provides population counts only; further information on population characteristics is not available on such a detailed level.

Detailed demographic information collected in the 20 percent sample Census (long form) is available in the series General Social and Economic Characteristics (PC80-1C) and Detailed Population Characteristics (PC80-1-D). General Social and Economic Characteristics provides demographic data to the town or township level of detail according to states. A U.S. summary report is also included in the series. Detailed Population Characteristics is available by state, U.S. summary, and SMSA. These two reports provide considerable information on the population characteristics previously listed in Table 1.

All of the information sources previously discussed contain results from the 1980 Census; they are available in most reference libraries. Specific population data that have been collected in 1980 and that have not yet been released may be obtained by calling the Population Division of the Bureau of the Census (202-763-5002 or 5020).

Table 3. Information on 1980 Census Reports: Their Geographical Breakdown, Characteristics, and Expected Dates of Release

Series	Name	Geographical breakdown	Characteristics	Expected dates of release
PC80-1-A (complete count data - 100%)	Number of inhabitants (U.S. Summary and by state)	United States Regions Divisions States SCSAs, SMSAs Urbanized areas Incorporated places Counties County subdivisions	Population counts	Available
PC80-1-B (complete count data - 100%)	General Population Characteristics (U.S. Summary and by state)	United States Regions Divisions States SCSAs, SMSAs Urbanized areas Places & towns/townships of 1,000 or more Counties Rural portion of counties	Population counts by sex	Available
		United States States SCSAs, SMSAs Urbanized areas Places & towns/townships of 10,000 to 50,000 Places & towns/townships of 2,500 to 10,000 Counties	Age and sex, household type & relationship, type of family, and marital status	

Table 3. (continued)

Series	Name	Geographical breakdown	Characteristics	Expected dates of release
PC80-1-C (sample estimate data - 20%)	General Social and Economic Characteristics (U.S. Summary and by state)	United States Regions Divisions States SCSAs, SMSAs Urbanized areas Place & towns/ townships of 50,000 or more Places & towns/ townships of 2,500 to 10,000 counties	Population counts	Mid to late 1983
		United States States Counties	Population counts for non-rural and rural farms.	
		United States States	Age & sex, fertility, household relationship, education, family composition, nativity and place of birth, residence in 1975, journey to work, disability status, veteran status, labor force status, class of worker, industry and occupation, income and poverty status.	
		States SMSAs[d] Urbanized areas[d] Places & towns/ townships of 50,000 or more[d] Central cities[d] Places & towns/ townships of 10,000 to 50,000[d] Counties	Age & sex, fertility, household relationship, education, family composition, marital status, nativity & place of birth, residence in 1975, journey to work, disability status, type of group quarters, veteran status, labor force status, class of worker, industry & occupation, income & poverty status.	

Table 3. (continued)

Series	Name	Geographical breakdown	Characteristics	Expected dates of release
PC80-1-D (sample estimate data - 20%)	Detailed Population Characteristics (U.S. Summary and by state)	United States States SMSAs of 250,000 or more	Cross-tabulations of social & economic characteristics by age, sex, etc.	Mid to late 1983
		States SMSAs of 250,000 or more[e]	Social and economic characteristics	
PHC80-2 (sample estimate data - 20%)	Census Tracts[b] (U.S. Summary and by SMSA)	SMSAs Central cities Counties Places of 10,000 or more Census tracts	Population counts (number of people in each tract by SMSA & other tracted areas)	Late 1983 (currently available on a photocopy basis)
		SMSA[c] Counties[c] Places of 10,000 or more[c] Census tracts[c]	Age and sex, fertility, household relationship, education, family composition, marital status, nativity, language usage and ability to speak English, residence in 1975, journey to work, disability status, labor force status, industry and occupation, income and poverty status. Structural equipment, financial and household characteristics of housing units.	

Table 3. (continued)

Series	Name	Geographical breakdown	Characteristics	Expected dates of release
PH80-1 (complete count data - 100%)	Block Statistics[a] (microfiche only; maps printed - U.S. Summary and by SMSA)	States SMSAs Counties County Subdivisions Places Tracts Blocks	Population counts	Available

Note: Data for towns/townships are shown for 11 states only: Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Michigan, and Wisconsin.

[a] Report contains 100% data; race and Spanish origin data, where presented, are provisional.
[b] Report contains both 100% and sample data.
[c] Data are shown only for those groups having 400 or more persons in the specific geographic area.
[d] Data for American Indian, Eskimo, and Aleut and Asian and Pacific Islander are shown for the specific geographic area having 1,000 or more persons of the population group.
[e] Data are shown only for those groups having 25,000 or more persons in the specific geographic area.

Source: Bureau of the Census, Customer Services Branch; Washington, D.C. (202-763-4100).

Another source of census information is the computerized Summary Tape Files (STFs). There are five basic files. STFs 1 and 2 are derived from the complete-count part of the Census and reflect respondents' answers to questions on the short form. STFs 3, 4, and 5 contain estimates derived from the sample part of the Census (20 percent sample) and cover the full range of topics represented on the long form. Although the source of information is the same, the STFs are designed to provide much greater geographic and subject detail (e.g., age, sex, education, marital status) than is feasible or desirable in printed reports. The STFs are only on magnetic computer tape, with the exception of STF 1A, which is also available on microfiche. Each of the five STFs is divided into Parts A, B, and C. Table 4 illustrates the relationships between the 1980 printed reports and STFs 1 through 5. Table 5 illustrates the geography of each file and its three parts. Table 6 lists the geographical resolution that will appear on the 1980 STFs, as well as the tentative schedule of release for these files.

Several other types of computer tape files are also available for population data (Bureau of the Census 1982a). Of particular importance is the Master Area Reference File (MARF). MARF contains numeric codes and names of all geographic areas used in the 1980 Census. The file also contains population and housing data for each area in the file. Donnelly Marketing, Incorporated, a subsidiary of Control Data Corporation, has acquired the file and added geographic coordinates (latitude-longitude) to all ED/BGs in MARF. This permits computerized mapping of the population data. This file along with the proprietary geographic coordinate data was recently purchased by EPA-OTS and entered into its Graphical Exposure Modeling System (GEMS). EPA-OTS can now access, aggregate, and manipulate 1980 population data as well as display the geographic distribution of the data in conjunction with ambient concentration data predicted by fate models. Details on MARF and its application as well as GEMS and the computerized concentration prediction models are discussed in the next subsection.

The STFs and other computer tape files such as MARF are considerably more expensive than printed reports. One STF reel (approximately one state) costs $140 compared to $5 for comparable printed reports. Computer tape files, however, increase the versatility of the population data; users can manipulate, aggregate, or otherwise extensively process census data.

Another source of population data that can be very useful, particulary in the study of specific geographic areas, is census maps. Census outline maps allow the investigator to determine the geographic distribution of populations in specific areas of interest. Maps that are available for use with 1980 census data vary according to the resolution needed (refer to Figure 5) and conform to the geographic units already described in Table 2. The census outline maps available for use with 1980 census data are summarized in Table 7.

Table 4. Relationship of 1980 Summary Tape Files, Printed Reports, and Microfiche

Type of data	1980 STFs	1980 Printed reports		Microfiche	
100%	STF 1	PHC80-V	Advanced Reports	PHC80-1	Block Statistics
		PHC80-3	Summary Statistics for Government Units	STF 1-A	
		PC80-1-A	Number of Inhabitants		
100%	STF 2	PC80-1-B	General Population Characteristics	PHC80-2	Census Tracts
		HC80-1A	General Housing Characteristics		
Sample	STF 3	PHC80-3	Summary Characteristics for Government Units		
Sample	STF 4	HC80-1-B	Detailed Housing Characteristics	PHC80-2	Census Tracts
		PC80-1-C	General Social and Economic Characteristics		
Sample	STF 5			PC80-1-D	Detailed Population Characteristics
				HC80-2	Metropolitan Housing Characteristics

Source: Bureau of the Census 1980b.

Table 5. Summary Tape File Geography (1980)

STF	File A (state-by-state release)	File B (state-by-state release)	File C (national files - follow release of all states for each STF)
STF 1 (100%)	Block groups/enumeration districts, block numbered areas/tracts, MCDs/CCDs, places, counties, states.	Blocks, EDs, block numbered areas, tracts, MCDs, places, counties, SMSAs, states.	MCDs of over 10,000 persons in 11 states, places of over 10,000 population, counties, urbanized areas, SMSAs, SCSAs, states, divisions, regions, U.S. Congressional districts.
STF 2 (100%)	Tracts, places, tracted counties, SMSAs.	MCDs/CCDs, places, counties, rural population, urbanized areas, SMSAs, SCSAs, Indian reservations.	MCDs of over 10,000 persons in 11 states, large places, rural population, counties, urbanized areas, SMSAs, SCSAs, states, divisions, regions, U.S., Indian reservations.
STF 3 (sample)	Enumeration districts/block groups, tracts, MCDs/CCDs, places, counties, Congressional districts, states.	Zip codes (cancelled)[1]	MCDs of over 10,000 persons in 11 states, large places, counties, urbanized areas, SMSAs, SCSAs, Congressional districts, states, divisions, regions, U.S.
STF 4 (sample)	Tracts, places over 10,000 tracted counties, SMSAs.	MCDs/CCDs, places, counties, rural population, urbanized areas, SMSAs, SCSAs, states, Indian reservations.	MCDs over 10,000 persons in 11 states, large places, rural population, counties, urbanized areas, SMSAs, SCSAs, states, divisions, regions, U.S., Indian reservations.
STF 5 (sample) Places and counties of over 50,000, SMSAs, central cities, states, divisions, regions.	It has not yet been decided whether STF 5 will appear in three parts, A, B, and C.		

Source: Bureau of the Census 1982a.

[1] STF 3-B not available for public use; STF 3 data for 5-digit ZIP code may be available in the future on a cost reimbursable, special tabulation basis.

Table 6. Smallest Type of Area on 1980 Census Summary Tape Files

	File A (state-by-state)	File B (state-by-state)	File C (national)	Tentative dates of release
Complete Count:				
STF 1	BG/ED	Blocks/ED	County, place of 10,000 or more	Available
STF 2	Tract	Place of 1,000 or more, MCD/CCD	County, place of 10,000 or more	Available
Sample:				
STF 3	BG/ED	-	County, place of 10,000 or more	STF 3A is available STF 3B has been cancelled STF 3C expected in mid 1983
STF 4	Tract	Place of 2,500 or more, MCD/CCD	County, place of 10,000 or more	Mid to late 1983
STF 5		SMSA, County of 50,000 or more, place of 50,000 or more		Late 1983

Source: Customer Services Division, Bureau of the Census (202-763-4100).

Table 7. Census Outline Maps

Map series	Map scale	Number of map sheets	Size of map sheets	Availability	
				in reports	separate
METROPOLITAN MAP SERIES cover urbanized areas of SMSAs and contain all census boundaries down to the block level	1" = 2,000'	Varies according to size of urbanized areas	18" x 24"	HC(3)	From $1.50 each sheet[1]
COUNTY MAPS-contain boundaries, minor civil divisions, census county divisions, incorporated places, tracts, and enumeration districts	Generally, 1" = 2 miles	Varies from 1 to as many as 64 per county	Generally, 18" x 24"	-	From $1.50 each sheet[1]
PLACE MAPS-for incorporated and unincorporated places; contain tract and enumeration district boundaries	Varies according to size of place; range from 1" = 400' to 1" = 1,500'	Generally, 1 map sheet per place	Varies according to size of place	HC(3)	From $2.25 each sheet[1]
COUNTY SUBDIVISION MAPS-contain information similar to county maps and include township and city boundaries	Generally, 1" = 12 miles	Generally, 1 map sheet per state	3' x 4'	PC(1)-A	$1.00 each sheet[2]
TRACT OUTLINE MAPS-show tract boundaries and incorporated limits for places of 25,000 or more population	Varies according to size of SMSA and complexity of tracted areas; range from 1" = 1/2 mile to 1" = 10 miles	Generally, 2 map sheets per SMSA	Generally, 22" x 24"	PHC(1)	Prices vary[1]
URBANIZED AREA MAPS-shows the extent of urbanized areas by grey shading	Generally 1" = 4 miles	Generally, 1 map sheet per UA	17" x 22"	PC(1)-A HC(1)-A	-
UNITED STATES MAP OF COUNTIES-contains boundaries for counties and equivalents	115,000,000	1 map sheet	30" x 40"	-	$1.00 each sheet[2]

[1] Available from: Customer Services Branch, Data Users Services Division, Bureau of the Census, Washington, D.C. 20233

[2] Available from: Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, or any U.S. Department of Commerce Field Office.

The metropolitan, tract outline, and county subdivision maps are the key census maps for correlating 1980 census data to sites in urban or rural areas. These map series are issued separately or with specific census publications. Examples of census outline maps for metropolitan and non-metropolitan areas are presented in Figure 7.

Additionally, the Census Bureau issues several series of statistical maps and graphic summaries that display census data in map form. The map series in this category include the GE-50, GE-70, and GE-80 (Urban Atlas) series. These maps, of varying sizes and scales, utilize color schemes to illustrate population and other social and economic census data.

All printed census matter is available for purchase through the Government Printing Office (GPO); all series issued on microfiche, maps, computer tapes, and technical documentation are available directly from the Customer Services Branch at the Bureau of the Census, Department of Commerce, Washington, D.C. These series can be ordered by calling (202) 763-4100 (Customer Services Branch).

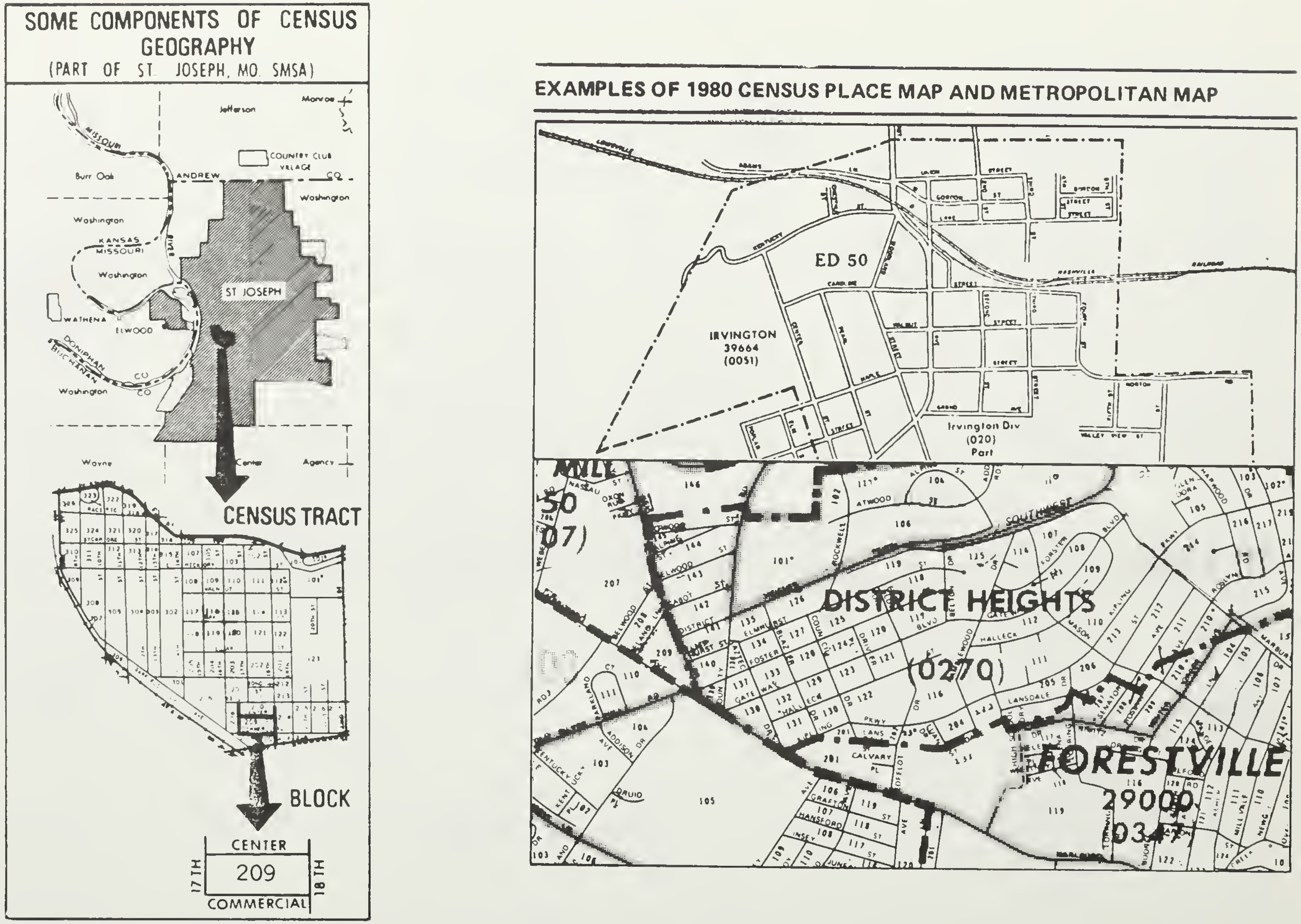
The Bureau of the Census will also prepare, on a cost reimbursable basis, special tabulations of data from the 1980 Census based on customer specifications. Such tabulations can cover any specific geographic or subject matter area as long as the requests do not violate confidentiality restrictions. These types of reports are expensive and may require considerable time to produce. Standard reports, tapes, and microfiche should be used whenever possible.

A complete description of the documents and services available from the Bureau of the Census is not within the scope of this volume. This subsection has attempted to briefly describe the documents and data files that would be of most use towards enumerating populations exposed to chemical substances in the ambient environment. For more detailed descriptions of the documents and data files previously discussed, or for information on other services available from the Bureau of the Census, the investigator should contact:

Data User Services Division
Bureau of the Census
Washington, DC 20233
(202) 763-4100

A detailed list of contacts for census data information is provided in Figure 8.

The population data discussed in this report reflect information collected in 1980, and, therefore, are not up-to-date. Population data for large statistical reporting areas or categories (e.g., regions, divisions, states, urban areas, SMSAs) will not have changed



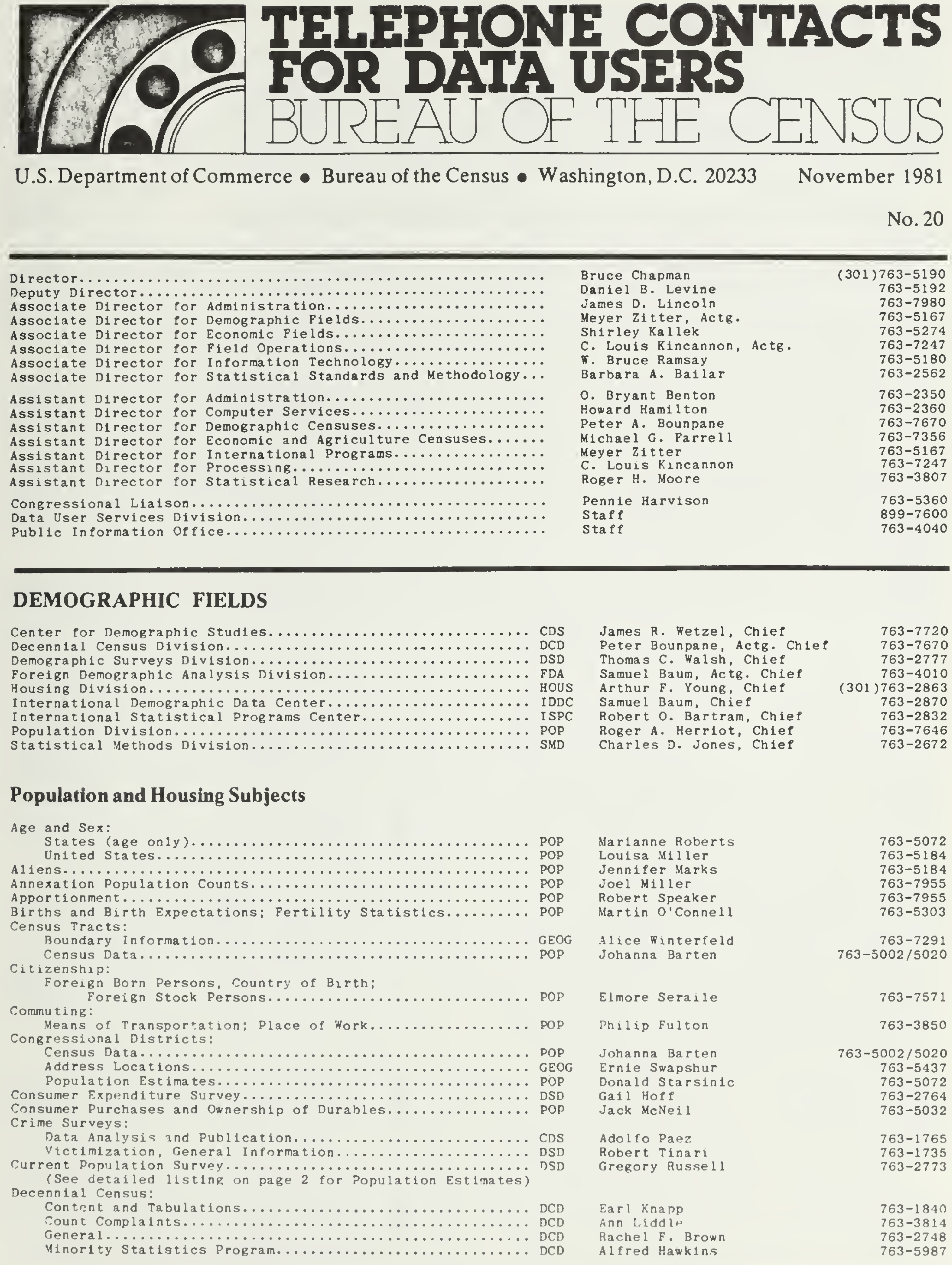
SOME COMPONENTS OF CENSUS GEOGRAPHY (PART OF ST. JOSEPH, MO. SMSA)

EXAMPLES OF 1980 CENSUS PLACE MAP AND METROPOLITAN MAP

Jefferson
Monroe
COUNTRY CLUB VILLAGE
Burr Oak
ANDREW CO
Washington
KANSAS
MISSOURI
MISSOURI
RIVER
ST JOSEPH
WATHENA
ELWOOD
DONIPHAN
BUCHANAN
CO
Wayne
Center
Agency
CENSUS TRACT
BLOCK
CENTER
209
17TH
18TH
COMMERCIAL
ED 50
IRVINGTON
39664
(0051)
Irvington Div
(020)
Part
DISTRICT HEIGHTS
(0270)
FORESTVILLE
29000
0347

Figure 7. Examples of Census Maps

Source: Bureau of the Census (1980c and 1981a).



TELEPHONE CONTACTS FOR DATA USERS
BUREAU OF THE CENSUS

U.S. Department of Commerce • Bureau of the Census • Washington, D.C. 20233 November 1981

No. 20

Director	Bruce Chapman	(301)763-5190
Deputy Director	Daniel B. Levine	763-5192
Associate Director for Administration	James D. Lincoln	763-7980
Associate Director for Demographic Fields	Meyer Zitter, Actg.	763-5167
Associate Director for Economic Fields	Shirley Kallek	763-5274
Associate Director for Field Operations	C. Louis Kincannon, Actg.	763-7247
Associate Director for Information Technology	W. Bruce Ramsay	763-5180
Associate Director for Statistical Standards and Methodology	Barbara A. Bailar	763-2562
Assistant Director for Administration	O. Bryant Benton	763-2350
Assistant Director for Computer Services	Howard Hamilton	763-2360
Assistant Director for Demographic Censuses	Peter A. Bounpane	763-7670
Assistant Director for Economic and Agriculture Censuses	Michael G. Farrell	763-7356
Assistant Director for International Programs	Meyer Zitter	763-5167
Assistant Director for Processing	C. Louis Kincannon	763-7247
Assistant Director for Statistical Research	Roger H. Moore	763-3807
Congressional Liaison	Pennie Harvison	763-5360
Data User Services Division	Staff	899-7600
Public Information Office	Staff	763-4040

DEMOGRAPHIC FIELDS

Center for Demographic Studies	CDS	James R. Wetzel, Chief	763-7720
Decennial Census Division	DCD	Peter Bounpane, Actg. Chief	763-7670
Demographic Surveys Division	DSD	Thomas C. Walsh, Chief	763-2777
Foreign Demographic Analysis Division	FDA	Samuel Baum, Actg. Chief	763-4010
Housing Division	HOUS	Arthur F. Young, Chief	(301)763-2863
International Demographic Data Center	IDDC	Samuel Baum, Chief	763-2870
International Statistical Programs Center	ISPC	Robert O. Bartram, Chief	763-2832
Population Division	POP	Roger A. Herriot, Chief	763-7646
Statistical Methods Division	SMD	Charles D. Jones, Chief	763-2672

Population and Housing Subjects

Age and Sex:			
States (age only)	POP	Marianne Roberts	763-5072
United States	POP	Louisa Miller	763-5184
Aliens	POP	Jennifer Marks	763-5184
Annexation Population Counts	POP	Joel Miller	763-7955
Apportionment	POP	Robert Speaker	763-7955
Births and Birth Expectations; Fertility Statistics	POP	Martin O'Connell	763-5303
Census Tracts:			
Boundary Information	GEOG	Alice Winterfeld	763-7291
Census Data	POP	Johanna Barten	763-5002/5020
Citizenship:			
Foreign Born Persons, Country of Birth; Foreign Stock Persons	POP	Elmore Seraile	763-7571
Commuting:			
Means of Transportation; Place of Work	POP	Philip Fulton	763-3850
Congressional Districts:			
Census Data	POP	Johanna Barten	763-5002/5020
Address Locations	GEOG	Ernie Swapshur	763-5437
Population Estimates	POP	Donald Starsinic	763-5072
Consumer Expenditure Survey	DSD	Gail Hoff	763-2764
Consumer Purchases and Ownership of Durables	POP	Jack McNeil	763-5032
Crime Surveys:			
Data Analysis and Publication	CDS	Adolfo Paez	763-1765
Victimization, General Information	DSD	Robert Tinari	763-1735
Current Population Survey	DSD	Gregory Russell	763-2773
(See detailed listing on page 2 for Population Estimates)			
Decennial Census:			
Content and Tabulations	DCD	Earl Knapp	763-1840
Count Complaints	DCD	Ann Liddle	763-3814
General	DCD	Rachel F. Brown	763-2748
Minority Statistics Program	DCD	Alfred Hawkins	763-5987

Figure 8

Population and Housing Subjects-Con.

Decennial Census--con.			
Special Tabulations:			
Population Data	POP	Paula Schneider	763-7962
Housing Data	HOUS	Bill Downs	763-2873
Disability	POP	Jack McNeil	763-5032
Education; School Enrollment and Social Stratification	POP	Paul Siegel	763-5050
Employment; Unemployment; Labor Force	POP	T. Palumbo/V. Valdisera	763-2825
Farm Population	POP	Diana DeAre	763-7955
Health Surveys	DSD	Robert Mangold	763-5508
Households and Families:			
Marriage and Divorce	POP	James Weed	763-7950
Projections	POP	Robert Grymes	763-7950
Size; Number; Social Characteristics	POP	Steve Rawlings	763-7950
Housing:			
Annual Housing Survey	HOUS	Edward Montfort	763-2881
Components of Inventory Change Survey	HOUS	Elmo Beach	763-1096
Contract Block Program	HOUS	Richard Knapp	763-2873
Housing Information, Decennial Census	HOUS	Bill Downs	763-2873
Housing Vacancy Data	HOUS	Stanley Rolark	763-2880
Market Absorption	HOUS	Charles Clark	763-2866
Residential Finance	HOUS	Peter Fronczek	763-2866
(See also Economic Subjects--Construction Statistics)			
Income Statistics:			
Current Surveys	POP	M. Henson/E. Welniak	763-5060
Decennial Statistics	POP	G. Patterson/R. Sanders	763-5060
Household	POP	Robert Cleveland	763-5060
Revenue Sharing	POP	Dan Burkhead	763-5060
Incorporated/Unincorporated Places	POP	Joel Miller	763-7955
Industry and Occupation Statistics (See also Economic Fields)	POP	John Priebe/Paula Vines	763-5144
Institutional Population	POP	Arlene Saluter	763-7950
International Population	POP	Samuel Baum	763-2870
Language, Current; Mother Tongue	POP	Paul Siegel	763-5050
Longitudinal Surveys	DSD	George Gray	763-2764
Marital Status; Living Arrangements	POP	Arlene Saluter	763-7950
Metropolitan Areas (see SMSA's)			
Migration	POP	Kristin Hansen	763-3850
Neighborhood Statistics	DCD	Joanne Eitzen	763-1818
Outlying Areas (Puerto Rico, etc.)	POP	Jennifer Marks	763-5184
Population:			
General Information; Published Data from Censuses, Surveys, Estimates, and Projections	POP	Johanna Barten	763-5020(TDY)/763-5002
Population Estimates Methodology:			
Congressional Districts; SMSA's	POP	Donald Starsinic	763-5072
Counties; Federal-State Cooperative Program for Local Population Estimates	POP	Fred Cavanaugh	763-7722
Estimates Research	POP	Richard Irwin	763-7883
Local Areas; Revenue Sharing	POP	Fred Cavanaugh	763-7722
States	POP	Marianne Roberts	763-5072
United States (National)	POP	Louisa Miller	763-5184
Population Projections Methodology:			
National	POP	Gregory Spencer	763-5021
State	POP	Signe Wetrogan	763-5021
Poverty Statistics	POP	Arno Winard	763-5790
Current Surveys	POP	Carol Fendler	763-5790
Decennial Census/Poverty Areas	POP	Thomas Gelinne	763-5790
Prisoner Surveys:			
National Prisoner Statistics	DSD	Chester A. Bowie	763-2380
Data Analysis and Publication	CDS	John Wallerstedt	763-7968
Race and Ethnic Statistics:	POP	Nampeo McKenney	763-7890
American Indian Population	POP	K. Crook/E. Paisano	763-5910/-7572
Asian Americans	POP	P. Berman/P. Johnson	763-2607
Black Population	POP	D. Johnson/T. King	763-7572
Ethnic Populations	POP	Elmore Seraile	763-7571
Race	POP	Patricia Berman	763-2607
Spanish Population	POP	Edward Fernandez	763-5219
Religion	POP	Elmore Seraile	763-7571
Revenue Sharing (See Income Statistics; Population: General Information; Population Estimates Methodology; Economic Fields--Governments)			
Sampling Methods	SMD	Charles Jones	763-2672
Social Indicators	CDS	John Deshaies	763-2490
Social Stratification	POP	Paul Siegel	763-5050
Special Population Censuses	DCD	George Hurn	763-5806
Special Surveys	DSD	Linda R. Murphy	763-2061
SMSA's:			
Census and Estimates Data; Current Definitions	POP	Johanna Barten	763-5002/5020
New Criteria	POP	Richard Forstall	763-5591
Travel Surveys	DSD	Ron Dopkowski	763-1798
Urban/Rural Residence	POP	Diana DeAre	763-7955
Veteran Status	POP	Mark Littman	763-7962
Voting and Registration	POP	Jerry Jennings	763-5179
Voting Rights	POP	Gilbert Felton	763-5313

Figure 8 (continued)

ECONOMIC FIELDS

Agriculture Division	AGR	Arnold Bollenbacher, Chief	(301)763-5230
Business Division	BUS	Vacant	763-7564
Construction Statistics Division	CSD	Leonora M. Gross, Chief	763-7163
Economic Census Staff	ECS	Michael G. Farrell, Chief	763-7356
Economic Surveys Division	ESD	W. Joel Richardson, Chief	763-7735
Foreign Trade Division	FTD	Emanuel A. Lipscomb, Chief	763-5342
Governments Division	GOVS	John Coleman, Chief	763-7366
Industry Division	IND	Roger H. Bugenhagen, Chief	763-5850

Economic Subjects

Agriculture:			
Crop Statistics	AGR	Donald Jahnke	763-1939
Farm Economics	AGR	John Blackledge	763-5819
General Information	AGR	Arnold Bollenbacher	763-5170
Livestock Statistics	AGR	Thomas Monroe	763-1081
Puerto Rico, Guam, etc	AGR	Kenneth Norell	763-5914
Construction Statistics:			
Census/Industries Surveys	CSD	Alan Blum	763-5435
Special Trades; Contractors; General Contractor Built	CSD	Andrew Visnansky	763-7547
Construction Authorized by Building Permits (C40 Series) and Residential Demolitions (C45 Series)	CSD	David Fondelier	763-7244
Current Programs	CSD	William Mittendorf	763-7165
Expenditures on Residential Additions, Alterations, Maintenance and Repairs, and Replacements (C50 Series)	CSD	George Roff	763-5717
New Residential Construction:			
Housing Starts (C20 Series)	CSD	Barry Rappaport	763-7842
Housing Completions (C22 Series)	CSD	Juliana Van Berkum	763-7843
In Selected SMSA's (C21 Series)	CSD	Diana Farrelly	763-7842
Sales of New One-Family Homes (C25 Series)	CSD	Steve Berman	763-5731
Price Index for New One Family Homes (C27 Series)	CSD	Dorothy Walton	763-7314
Characteristics of New Housing (C25 Annual Report)	CSD	Dale Jacobson	763-5732
Value of New Construction Put in Place (C30 Series)	CSD	Allan Meyer	763-5717
County Business Patterns	ESD	Stanley Hyman	763-7642
Employment/Unemployment Statistics	POP	T. Palumbo/V. Valdisera	763-2825
Energy Related Statistics	DIRS	Elmer S. Biles	763-7184
Enterprise Statistics	ESD	John Dodds.	763-7086
Foreign Trade Information	FTD	Juanita Noone	763-5140
Governments:			
Criminal Justice Statistics	GOVS	Diana Cull	763-2842
Eastern States Government Sector	GOVS	G. Beaven/G.Speight	763-5017/-2890
Employment	GOVS	Alan Stevens	763-5086
Finance	GOVS	Vancil Kane	763-5847
Governmental Organization and Special Projects	GOVS	Muriel Miller	763-5308
Revenue Sharing (See also Demographic Fields)	GOVS	John Coleman	763-5272
Taxation	GOVS	John Behrens	763-2844
Western States Government Sector	GOVS	Ulvey Harris	763-5344
Industry and Commodities Classification	ESD	Walter Neece	763-1935
Manufactures:			
Census/Annual Survey of Manufactures	IND	B. J. Fitzpatrick	763-1503
Durables	IND	Dale Gordon	763-7304
Nondurables	IND	Michael Zampogna	763-2510
Subject Reports (Concentration, Production Index, Water, etc.)	IND	John Govoni	763-7666
Current Programs	IND	John Wikoff	763-7800
Durables	IND	Malcolm Burnhardt	763-2518
Environmental Surveys	IND	Wayne McCaughey	763-5616
Fuels/Electric Energy Consumed by Manufactures	IND	John McNamee	763-5938
Nondurables	IND	Elinor Champion	763-5911
Origin of Exports	IND	John Govoni	763-7666
Shipments, Inventories, and Orders	IND	Ruth Runyan	763-2502
Mineral Industries	IND	John McNamee	763-5938
Minority Businesses	ESD	Jerry McDonald	763-5182
Puerto Rico:			
Censuses of Retail Trade, Wholesale Trade, and Selected Service Industries	BUS	Alvin Barten	763-5282
Retail Trade:			
Annual Retail Trade Report; Advance Monthly Retail Sales; Monthly Retail Inventories Survey	BUS	Irving True	763-7660
Census	BUS	Dennis Pike	763-7038
Monthly Retail Trade Report: Accounts Receivable; and Monthly Department Store Sales	BUS	Irving True	763-7660
Service Industries:			
Census	BUS	Sid Marcus	763-7039
Current Selected Services Reports	BUS	Edward Gutbrod	763-7026
Transportation:			
Commodity Transportation Survey; Truck Inventory and Use; Domestic Movement of Foreign Trade Data	ESD	Robert Torene	763-5430
Wholesale Trade:			
Census	BUS	John Trimble	763-5281
Current Wholesale Sales and Inventories; Green Coffee Survey; Canned Food Survey	BUS	Ronald Piencykoski	763-7007

Figure 8 (continued)

GEOGRAPHY AND STATISTICAL RESEARCH

Geography Division	GEO	Stanley Matchett, Chief	(301)763-5636
Statistical Research Division	SRD	Roger H. Moore, Chief	763-3807

Boundaries and Annexations	GEO	Brian Scott	763-5437
Census Geography 1970/1980; Geographic Concepts	GEO	Staff	763-5720
Computer Graphics and Computer Mapping	GEO	Frederick Broome	763-7442
Congressional District Component Areas, Atlas	GEO	Kevin Shaw	763-5437
Earth Resources Satellite Technology:			
International	GEO	Robert Durland	763-2034
United States	GEO	James Davis	763-5808
GBF/DIME System	GEO	Staff	763-7315
Area Measurement and Centers of Population	GEO	Roy Borgstede	763-7856
Geographic Statistical Areas	GEO	Staff	763-2364
Census Maps	GEO	Staff	763-7818
Revenue Sharing Geography	GEO	Bob Bakondi	763-5437
Survey Methodology Information System	SRD	Patricia Fuellhart	763-7600

USER SERVICES

Administrative Services Division	ASD	Robert L. Kirkland, Chief	763-5400
Data User Services Division	DUSD	Michael G. Garland, Chief	899-7620
Field Division	FLD	Lawrence T. Love, Chief	763-5000

Age Search - Access to Personal Census Records	DUSD	Christine Stewart	899-7625
Bureau of the Census Catalog	DUSD	Ann King	899-7672
Census Procedures, History of	DUSD	Frederick Bohme	899-7625
Clearinghouse for Census Data Services	DUSD	John Kavaliunas	899-7732
College Curriculum Support Project	DUSD	Les Solomon	899-7755
Computer Tapes	DUSD	Customer Services	899-7600
Data User News (Monthly Newsletter)	DUSD	Neil Tillman	899-7670
Data User Training:			
Registration	DUSD	Dorothy Chin	899-7645
Seminars, Workshops, Conferences	DUSD	Deborah Barrett	899-7645
Directory of Data Files	DUSD	Customer Services	899-7600
Exhibits	DUSD	Douglas Moyer	899-7665
Guides and Directories	DUSD	Gary Young	899-7670
Library	ASD	Betty Baxtresser	763-5040
Circulation	ASD	Jim Thorne	763-1175
Interlibrary Loan	ASD	Staff	763-1930
Out of Print Publications	ASD	Maria Brown	763-5511
Reference Service	ASD	Grace Waibel	763-5042
Map Orders	DUSD	Customer Services	899-7600
Microfilm/Microfiche	DUSD	Customer Services	899-7600
Public Use Samples (Microdata)	DUSD	Paul Zeisset	899-7618
Reapportionment/Redistricting	DUSD	Cathy Talbert	899-7631
State Data Center Program	DUSD	Larry Carbaugh	899-7732
Statistical Compendia	DUSD	Glenn King	899-7650
Publication Orders (Subscriber Services)	DUSD	Customer Services	899-7600
User Software (CENSPAC, ADMATCH, etc.)	DUSD	Larry Finnegan	899-7634

Regional Assistance

Census Bureau Regional Offices	Information Services Specialists
Atlanta, GA	404/881-3312
Boston, MA	617/223-0226
Charlotte, NC	704/371-6144
Chicago, IL	312/353-0980
Dallas, TX	214/767-0625
Denver, CO	303/234-5825
Detroit, MI	313/226-4675
Kansas City, KS	816/374-4601
Los Angeles, CA	213/824-7291
New York, NY	212/264-4730
Philadelphia, PA	215/597-8313
Seattle, WA	206/442-1560

Census Bureau Satellite Offices	Information Services Specialists
Birmingham, AL	205/254-0040
Cincinnati, OH	513/684-2448
Columbia, SC	803/765-5435
Houston, TX	713/226-5457
Miami, FL	305/350-4064
San Antonio, TX	512/229-6018
San Francisco, CA	415/556-6372
Washington, DC	301/763-5830

Listing of Telephone Contacts for Data Users compiled by Carolyn Grace, User Training Branch, Data User Services Division, Bureau of the Census. Write for additional copies, or call 301/899-7645.

Figure 8 (continued)

significantly since the data were collected. Population estimates for these areas are published each year in Statistical Abstract of the U.S. (Bureau of the Census 1982b). Population data for detailed geographic areas (e.g., census tracts, enumeration districts, block groups), however, may have changed significantly since the data were collected. The Bureau of the Census does keep records of major population shifts and also has developed procedures and methodologies to estimate populations for periods between the decennial Censuses. A description of the procedures and methodologies is not within the scope of work of this volume. Information on these subjects may, however, be obtained from the Bureau of the Census at the above listed address.

2.3.2 Enumeration of Populations Exposed via Inhalation

As discussed in Subsection 2.2, populations exposed to chemical substances in the ambient environment via the inhalation route are identified on the basis of their geographic location with respect to the atmospheric source of the chemical substances. Atmospheric sources include airborne releases resulting from industrial processes, consumer products, disposal, incineration, transportation activities (e.g., spills and vehicular exhausts), stationary combustion processes (e.g., home heating), and airborne releases of unknown origin.

For the purposes of predicting ambient concentrations of the chemical substance and for purposes of identifying the population exposed, these atmospheric sources are divided into three categories: (1) point sources, (2) area sources, and (3) line sources. The following subsections present methods for enumerating the identified population in each of these three source categories. The methods have been developed keeping in mind the atmospheric modeling tools available to EPA and the major data bases that contain population information (discussed in the preceding section). The methods recommended have also been developed after consideration of the strengths and weaknesses of previous enumeration efforts or on-going efforts in other EPA offices. The following discussions, therefore, also include a review of any historical methods considered relevant to the recommended procedures.

(1) Point Sources. This subsection presents a procedure for enumerating populations exposed to atmospheric concentrations of chemical substances released from point sources. This subsection also presents a procedure to enumerate populations around point sources that are too numerous to deal with individually. These are called prototype point sources or, as frequently cited in the literature, general point sources. Both procedures initially rely on the estimate of atmospheric concentrations via a computer based atmospheric fate model. The acquisition of the population data is, however, operationally different. Enumeration of exposed populations around point sources requires

site-specific population data. Enumeration of populations around prototype point sources uses population density data for different Census defined geographic statistical categories depending on where the sources are located.

The recommended procedure for enumerating exposed populations around point sources is to use an integrated computer based fate model and population data retrieval program known as ATM-SECPOP, developed by the EPA Office of Toxic Substances, Exposure Evaluation Division (OTS-EED), and General Software Corporation. ATM-SECPOP integrates the output of a concentration prediction model, a population distribution data base, and graphic and mapping information displays. The integration affords a rapid and efficient means of generating and presenting exposure-related data resulting from the airborne release of chemical substances from point sources.

ATM-SECPOP estimates concentrations of chemical substances and enumerates the population exposed to these concentrations around point sources that release the chemical to air. The program combines the output of the Atmospheric Transport Model (ATM) (Patterson et al. 1982) and population data contained in the proprietary 1980 Master Area Reference File (MARF) (1980 Census Data) which is accessed via a population distribution model called SECPOP.

ATM calculates pollutant concentrations around a point source by combining data on the facility location, data on emission source characteristics, physiochemical data on the chemical of interest, and stored data on localized meteorological conditions. Pollutant concentrations are estimated for radial sectors around the point source as delineated by axes running in the 16 compass directions and 10 concentric rings at 0.5, 1, 2, 3, 4, 5, 10, 15, 25, and 50 kilometers from the source (illustrated in Figure 9). Concentrations are, therefore, calculated for a total of 160 sectors around the source. The user also has the option to specify the ring distances to which concentrations of the chemical substance will be calculated. Detailed information on the application and data input requirements of ATM are provided in Volume 2 of this series and in the GEMS Users Manual (GSC 1983).

MARF is a data file released by the Bureau of the Census, as previously discussed in Subsection 2.3.1, to which Donnelly Marketing, Incorporated has added the latitude-longitude coordinates of all ED/BGs in the U.S. The 1980 population and housing data in the file, therefore, may be accessed for geographic exposure analysis. The file contains records for states, counties, county subdivisions, places, census tracts, enumeration districts (EDs) in unblocked areas, and block groups in

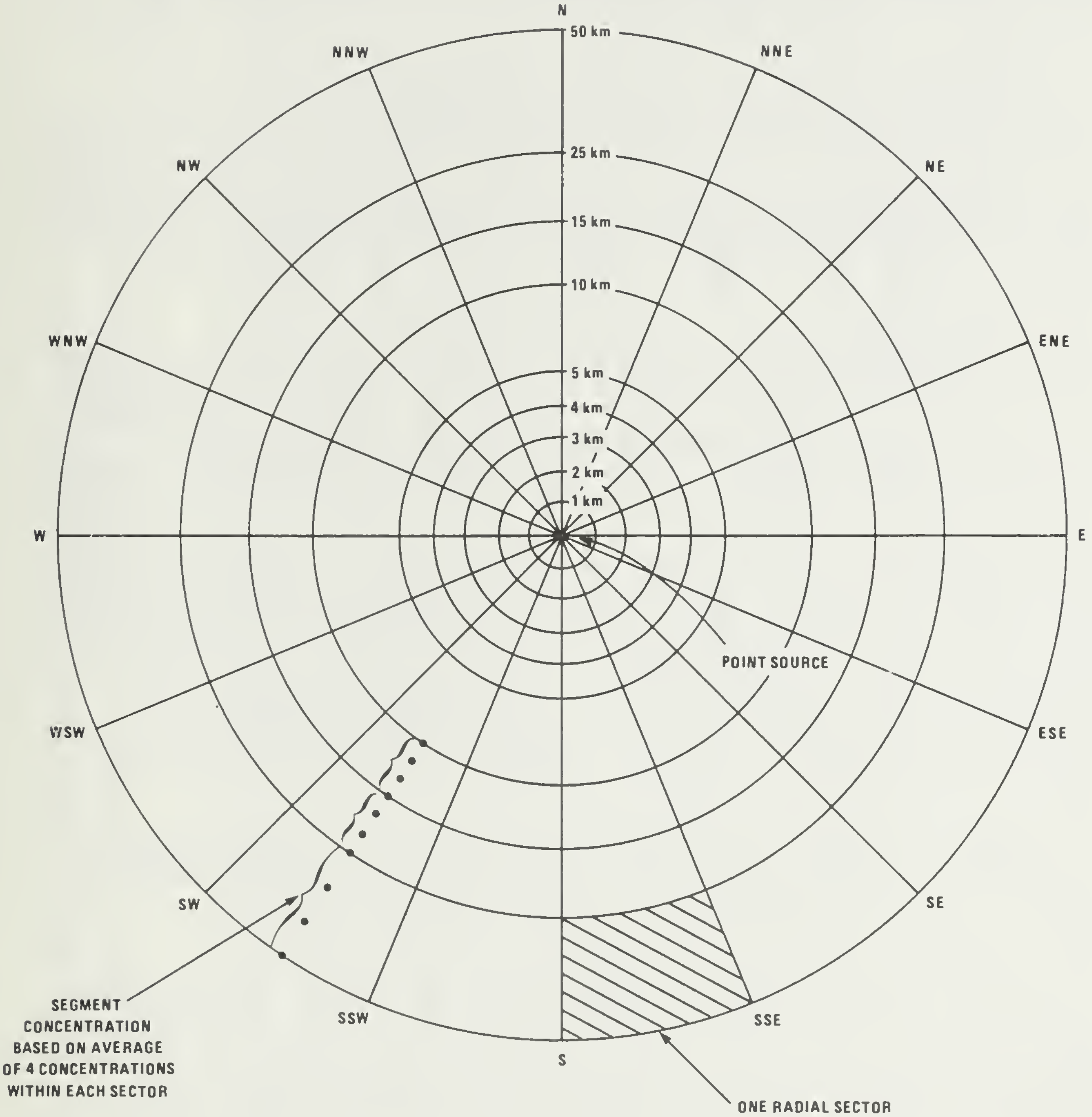

N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
50 km
25 km
15 km
10 km
5 km
4 km
3 km
2 km
1 km
POINT SOURCE
SEGMENT CONCENTRATION BASED ON AVERAGE OF 4 CONCENTRATIONS WITHIN EACH SECTOR
ONE RADIAL SECTOR

Figure 9. Wind Rose Sectors for ATM-SECPOP

blocked areas. Each record shows the total population by five race groups, population of Spanish origin, number of housing units, number of households, and number of families.

OTS-EED has recently acquired MARF and entered it into their Graphical Exposure Modeling System (GEMS) (GSC 1983). The file has been integrated with ATM via the SECPOP program. The SECPOP program retrieves the number of people or housing units within each radial sector defined by ATM. The concentration and population data are combined to provide tables on the estimated number of people exposed at various concentration levels. Figure 10 is a sample summary table of the output of an ATM-SECPOP model run.

GEMS also has graphic display capabilities. These functions may be used to illustrate the relationship of variables such as the distribution of exposure or concentration versus distance for any or all directions around a facility. GEMS provides prompts to the user to help in identifying other variables, which may be graphically displayed. Graphic displays may be in the form of bar charts and scatter plots as illustrated in Figures 11, and 12. The relative value of variables may also be displayed in "Rose" diagrams as illustrated in Figure 13. GEMS also has mapping capabilities for use in displaying the geographic distribution of ED/BGs around a facility as illustrated in Figure 14. A complete description of GEMS' capabilities is provided in the GEMS Users Manual (GSC 1983). Because of the proprietary nature of the data contained in MARF, ATM-SECPOP's use is restricted to personnel and contractors of EPA-OTS. Special arrangements for outside parties to use the data are, however, available. Inquiries should be directed to the Chemical Fate Branch Modeling Team of EPA-OTS.

Method 2-2 summarizes the data requirements and steps necessary to enumerate populations via the ATM-SECPOP program. A complete sample computer run of ATM-SECPOP for the point source emission of trichloroethane is provided in Appendix A-1 to this report.

The MARF data retrieved by SECPOP do not include the distribution by age and sex of the populations within the sectors, nor do they contain the additional census data in the 20 percent census count such as occupation, income, travel time, and form of transportation. This information must currently be obtained from forthcoming Census Bureau publications or STF 3 as discussed in Section 2.3.1 of this report. Numerous private sources of population data are also available; marketing companies can provide demographic data for particular geographic areas for a fee.

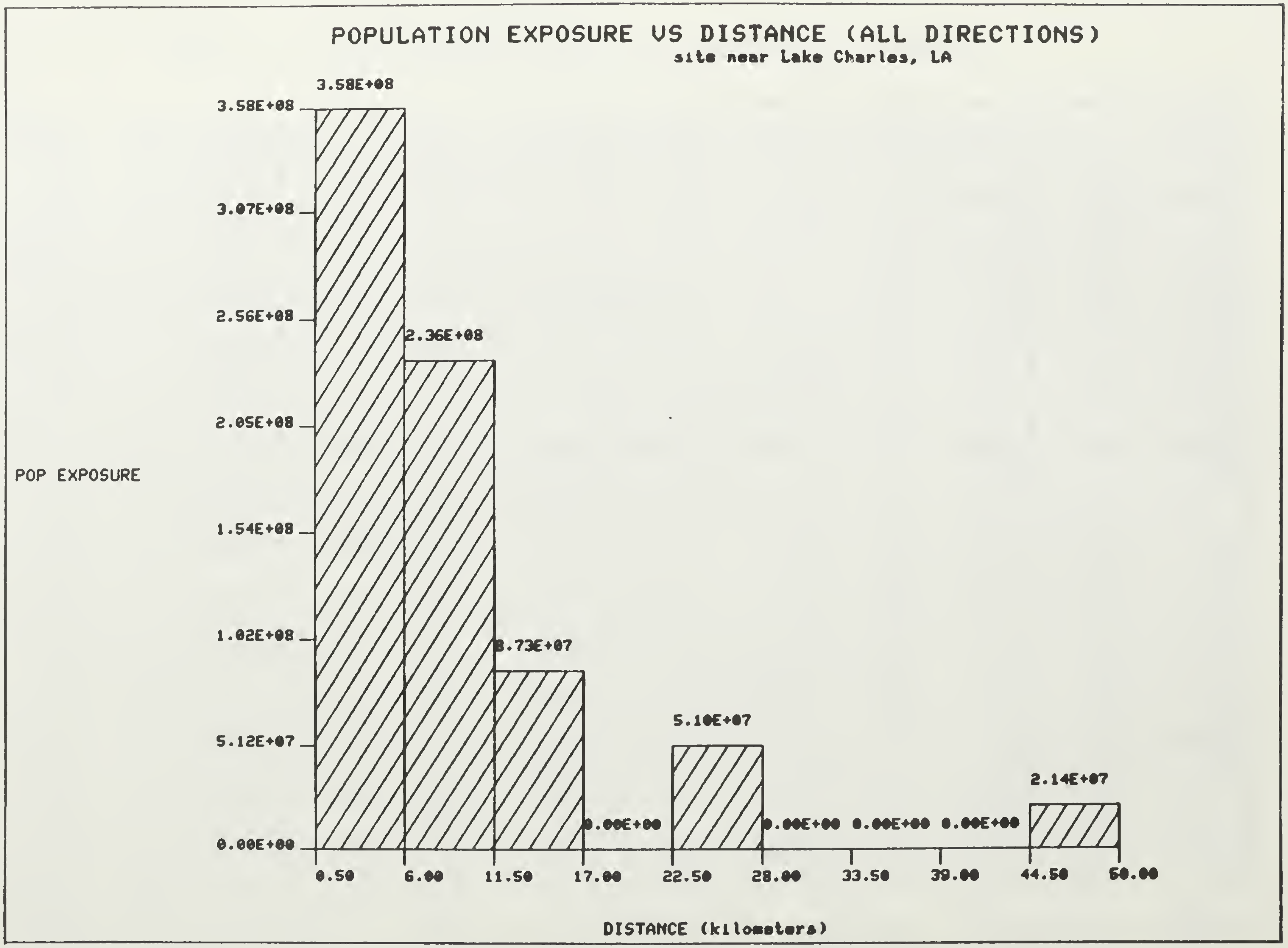
Point sources may at times be too numerous to deal with individually. This must be determined on a case-by-case basis and may be due to financial and manpower limitations or because the specific

```
                                                       SOURCE: LAKE CHARLES, LA          EMISSION TYPE: PROCESS
REPORTED TABULAR VALUES WITHIN INDIVIDUAL SECTOR SEGMENTS : ANNUAL AVERAGE CONCENTRATION (UG/M3)
                                                            POPULATION (PERSONS)
                                                          * POPULATION EXPOSURE (UG/YR)
* POPULATION EXPOSURE = ANNUAL AVERAGE CONCENTRATION * POPULATION * ANNUAL BREATHING RATE(22M3/DAY * 365 DAYS/YR)

DISTANCES (KM) :      0.0- 0.5  0.5- 1.0  1.0- 2.0  2.0- 3.0  3.0- 4.0  4.0- 5.0  5.0-10.0 10.0-15.0 15.0-25.0 25.0-50.0

SECTOR MID-ANGLE
    N         0.0    7.362E+00 4.470E+00 2.101E+00 8.987E-01 4.961E-01 3.138E-01 1.416E-01 4.914E-02 2.084E-02 6.849E-03
                             0         0         0         0         0         0         0         0         0      4119
                     0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 2.265E+05
  NNE        22.5    3.536E+00 1.825E+00 8.270E-01 3.485E-01 1.910E-01 1.202E-01 5.387E-02 1.849E-02 7.811E-03 2.601E-03
                             0         0         0         0         0         0         0      5238         0         0
                     0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 7.778E+05 0.000E+00 0.000E+00
   NE        45.0    3.405E+00 1.565E+00 7.368E-01 3.127E-01 1.715E-01 1.081E-01 4.837E-02 1.654E-02 6.972E-03 2.310E-03
                             0         0         0         0         0         0         0      2069       822      3104
                     0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 2.748E+05 4.602E+04 5.757E+04
  ENE        67.5    1.760E+00 9.769E-01 5.348E-01 2.340E-01 1.279E-01 7.977E-02 3.475E-02 1.121E-02 4.490E-03 1.386E-03
                             0         0         0         0         0         0     11383      3337       468      2189
                     0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 3.176E+06 3.005E+05 1.687E+04 2.436E+04
    E        90.0    2.207E+00 1.066E+00 5.365E-01 2.286E-01 1.236E-01 7.664E-02 3.316E-02 1.063E-02 4.272E-03 1.352E-03
                             0         0         0         0         0       638     20269      5560      4038      8324
                     0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 3.926E+05 5.396E+06 4.745E+05 1.385E+05 9.037E+04
  ESE       112.5    1.628E+00 9.181E-01 5.045E-01 2.199E-01 1.196E-01 7.421E-02 3.203E-02 1.016E-02 4.024E-03 1.232E-03
                             0         0         0         0         0       430     21498         0       538      1413
                     0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 2.563E+05 5.529E+06 0.000E+00 1.738E+04 1.398E+04
   SE       135.0    2.167E+00 1.139E+00 5.829E-01 2.507E-01 1.366E-01 8.518E-02 3.727E-02 1.220E-02 4.977E-03 1.593E-03
                             0         0         0         0         0         0     15009         0      1179      1005
                     0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 4.492E+06 0.000E+00 4.712E+04 1.286E+04
  SSE       157.5    2.339E+00 1.285E+00 6.075E-01 2.602E-01 1.438E-01 9.107E-02 4.115E-02 1.431E-02 6.089E-03 2.011E-03
                             0         0         0         0         0         0      1046         0        73         0
                     0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 3.457E+05 0.000E+00 3.569E+03 0.000E+00
    S       180.0    5.754E+00 3.223E+00 1.556E+00 6.623E-01 3.615E-01 2.264E-01 1.003E-01 3.372E-02 1.410E-02 4.640E-03
                             0         0         0         0         0         0         0      1420         0      4049
                     0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 3.845E+05 0.000E+00 1.509E+05
  SSW       202.5    3.442E+00 2.182E+00 1.130E+00 4.899E-01 2.684E-01 1.680E-01 7.405E-02 2.453E-02 1.004E-02 3.175E-03
                             0         0         0         0         0         0       815         0         0      1678
                     0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 4.846E+05 0.000E+00 0.000E+00 4.279E+04
   SW       225.0    4.265E+00 2.794E+00 1.471E+00 6.397E-01 3.507E-01 2.195E-01 9.660E-02 3.187E-02 1.300E-02 4.063E-03
                             0         0         0         0         0       787         0         0         0       257
                     0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 1.387E+06 0.000E+00 0.000E+00 0.000E+00 8.385E+03
  WSW       247.5    6.213E+00 3.745E+00 1.885E+00 8.124E-01 4.457E-01 2.798E-01 1.240E-01 4.155E-02 1.716E-02 5.450E-03
                             0         0         0         0         0         0      2371      2345       179     27293
                     0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 2.362E+06 7.825E+05 2.466E+04 1.194E+06
    W       270.0    6.490E+00 3.308E+00 1.558E+00 6.579E-01 3.585E-01 2.245E-01 9.932E-02 3.330E-02 1.384E-02 4.510E-03
                             0         0         0         0         0         0     13619       585       147     12107
                     0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 1.086E+07 1.565E+05 1.634E+04 4.384E+05
  WNW       292.5    4.225E+00 2.395E+00 1.142E+00 4.867E-01 2.673E-01 1.683E-01 7.525E-02 2.565E-02 1.074E-02 3.479E-03
                             0         0         0         0       639       652      3229      3325       253      8451
                     0.000E+00 0.000E+00 0.000E+00 0.000E+00 1.371E+06 8.812E+05 1.951E+06 6.849E+05 2.182E+04 2.361E+05
   NW       315.0    4.426E+00 2.730E+00 1.343E+00 5.807E-01 3.214E-01 2.034E-01 9.155E-02 3.149E-02 1.321E-02 4.242E-03
                             0         0         0       167       872         0         0         0       199      1091
                     0.000E+00 0.000E+00 0.000E+00 7.787E+05 2.250E+06 0.000E+00 0.000E+00 0.000E+00 2.111E+04 3.717E+04
  NNW       337.5    3.536E+00 2.242E+00 1.068E+00 4.590E-01 2.541E-01 1.611E-01 7.295E-02 2.546E-02 1.083E-02 3.549E-03
                             0         0         0         0       555         0      2487         0         0     10002
                     0.000E+00 0.000E+00 0.000E+00 0.000E+00 1.133E+06 0.000E+00 1.457E+06 0.000E+00 0.000E+00 2.850E+05
*
```

Figure 10. Sample ATM-SECPOP Output for Concentration, Population, and Population Exposure



Note: Population exposure = annual average concentration x population x annual breathing rate ($22\ m^3$/day x 365 days/yr).

Figure 11. Sample ATM-SECPOP Graphic Display: Bar Chart of Population Exposure vs. Distance

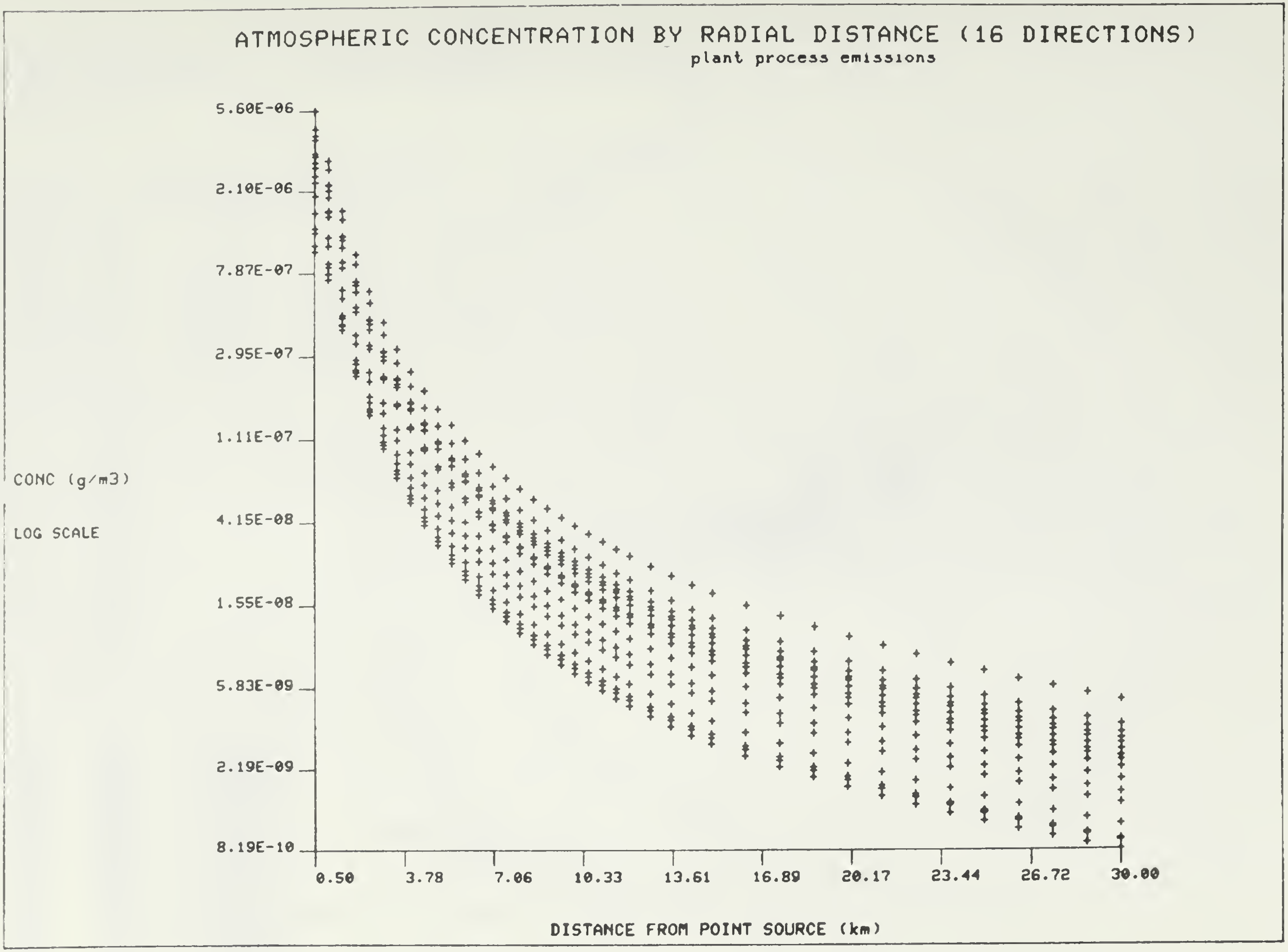


Figure 12. Sample ATM-SECPOP Graphic Display: Line Plot of Concentration vs. Distance

SOURCE: PLANT NEAR LAKE CHARLES, LA   EMISSION TYPE: PROCESS   RADIUS OF STUDY AREA: 50km

DATA TYPE = POPULATION EXPOSED   LEVEL = 1.00E-02 UG/M3 AND ABOVE

SECTOR	ANGLE	(PERSONS)
N	0.0	0.000E+00
NNE	22.5	5.238E+03
NE	45.0	2.069E+03
ENE	67.5	1.472E+04
E	90.0	2.647E+04
ESE	112.5	2.193E+04
SE	135.0	1.501E+04
SSE	157.5	1.046E+03
S	180.0	1.420E+03
SSW	202.5	8.150E+02
SW	225.0	7.870E+02
WSW	247.5	4.895E+03
W	270.0	1.435E+04
WNW	292.5	8.098E+03
NW	315.0	1.238E+03
NNW	337.5	3.042E+03

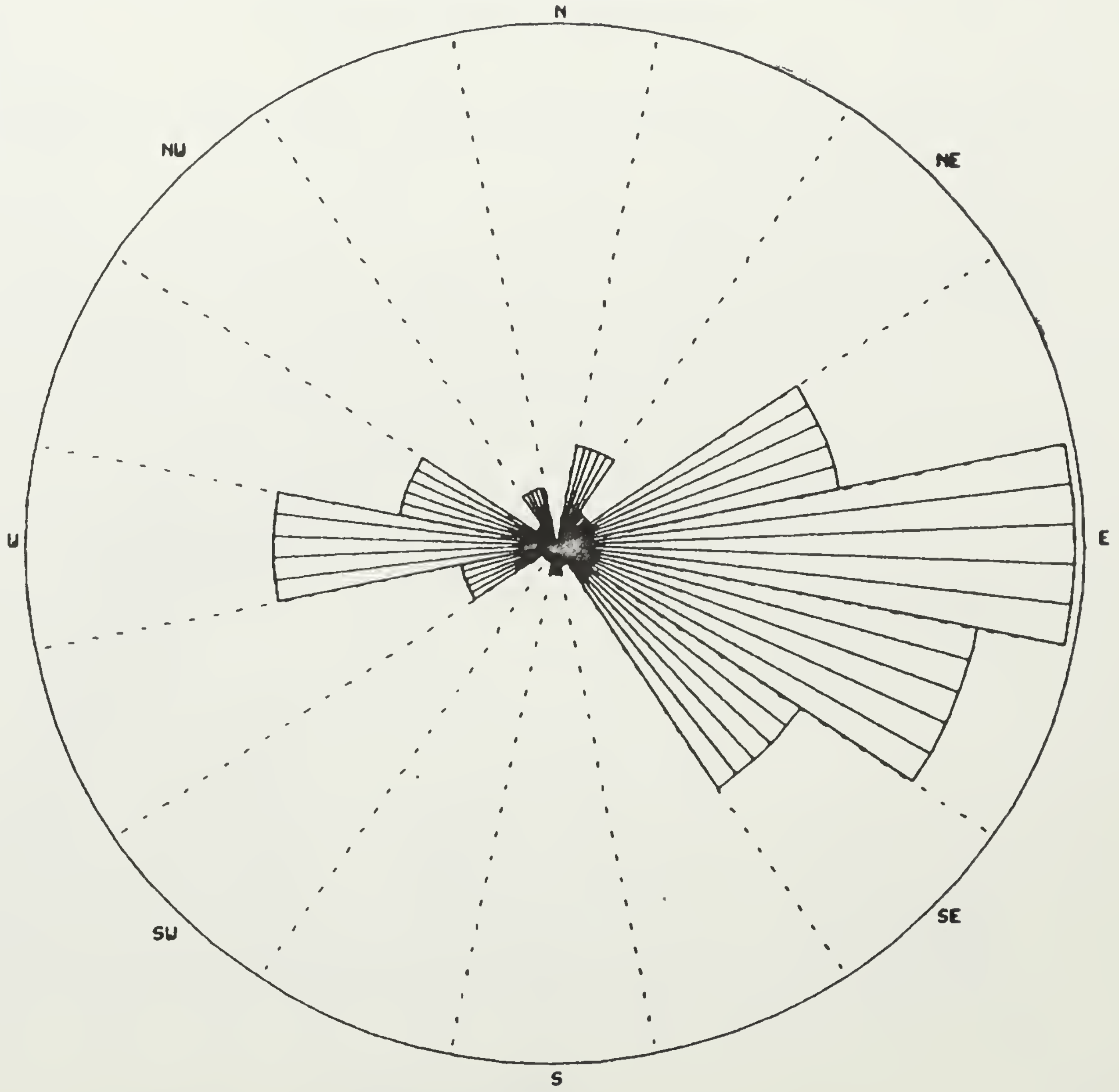


Figure 13. Sample ATM-SECPOP Graphic Display: Rose Diagram of Population Exposed

```
THE PLOT CENTER IS AT:
LATITUDE   30.2206
LONGITUDE   93.2817


     RADII                 POPULATION
From      To     Within Ring    Cumulative
------------------------------------------
 0.00    0.50            0             0
 0.50    1.00            0             0
 1.00    2.00            0             0
 2.00    3.00          167           167
 3.00    4.00         2066          2233
 4.00    5.00         2507          4740
 5.00   10.00        91726         96466
10.00   15.00        23879        120345
15.00   25.00         7896        128241
25.00   50.00        85082        213323

QUADRANT TOTALS:
Sector  Population
N             4119
NNE           5238
NE            5995
ENE          17377
E            38829
ESE          23879
SE           17193
SSE           1119
S             5469
SSW           2493
SW            1044
WSW          32188
W            26458
WNW          16549
NW            2329
NNW          13044
```

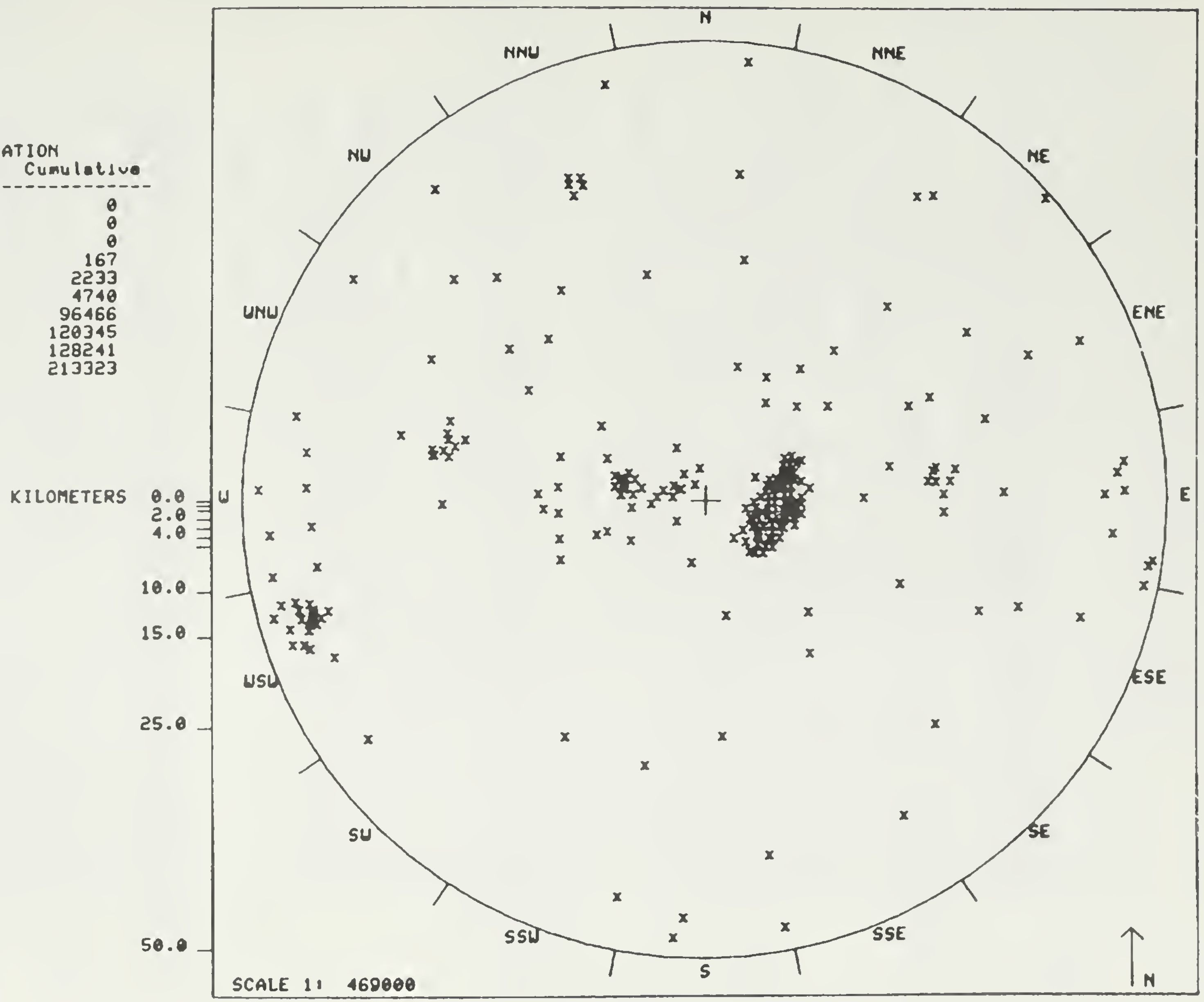

Population around site near Lake Charles, Louisiana
KILOMETERS
0.0
2.0
4.0
10.0
15.0
25.0
50.0
N
NNW
NNE
NW
NE
WNW
ENE
W
E
WSW
ESE
SW
SE
SSW
SSE
S
SCALE 1: 469000
N

Figure 14. Sample of ATM-SECPOP Mapping of ED/BGs Around a Point Source

Method 2-2. Enumeration of Populations Exposed via Inhalation to Atmospheric Concentrations of Chemical Substances Released from Point Sources

Step 1 Identify the location of the point source(s). Locations can be identified by latitude-longitude or by ZIP code. Latitude-longitude of point source(s) is preferred for reasons of accuracy.

Step 2 The investigator has the option to obtain: (1) concentration and exposed population data via ATM-SECPOP or (2) only population data within radii and sectors around a point source via SECPOP. For population data only, proceed to Step 3. To estimate the atmospheric concentration of the chemical substance around the point source(s) via ATM, it will be necessary to gather site-specific or generic emission characteristics of the point source(s) and chemical substance of interest. It will also be necessary to gather information on the physiochemical properties of the chemical substance. Volume 2 of this series discusses sources of information on site-specific and generic emission characteristics, and physiochemical properties of chemical substances required for ATM.

Step 3 Run ATM-SECPOP. The user must log on the GEMS system at 484-4540 or 4541 with an appropriate account number and password. GEMS is a "user friendly" system and will prompt the user according to the required data entries and available default values. Information on GEMS or ATM-SECPOP may be obtained from the GEMS User's Manual (GSC 1983) or from the EPA-Chemical Fate Branch Modeling Team, Exposure Evaluation Division, Office of Toxic Substances. Concentration results can be plotted graphically against population data. The investigator should consult graphic capabilities of GEMS.

Option

To access population data only, the user, on the first operational prompt, should enter GEODATA HANDLING (GH) operation, then either the Census Data (CD) or Radii-5 (R) procedure to generate a data table or map display, respectively. Follow prompts for entering latitude-longitude (or ZIP code) and the band or distance from the source for which population data are desired. The data resulting from the Census Data procedure will be population count and number of housing units in tabular form. If the user requires the data to be plotted on a map (see Figure 14) and aggregated by distance and direction, he should enter RADII 5 in place of code CD

Note: The EPA-OTS Chemical Fate Branch Modeling Team can also extract population records by state and region from MARF for specific exposure assessment efforts. Population data can then be retrieved by the user according to counties (using FIPS code) and SMSAs. The modeling team requires advance notice for this type of operation because it is more complex then the two previously described procedures.

locations of the point sources are unknown. Preliminary exposure assessments may also require only order-of-magnitude estimates of concentrations and exposed populations. In each of these cases, the estimation of atmospheric concentrations of a substance can be based on the development of a prototype point source. Generic emission characteristics representative of the point sources of interest are gathered, and concentrations are modeled via ATM for one or a series of locations to represent the range of possible ambient air concentrations around the sources. Volume 2 of this series provides a detailed discussion on the development of prototype point sources.

The enumeration of exposed populations also depends on the development of a prototype. The population prototype in turn depends on area and the estimated population density for each of the ATM-defined radial sectors (see Figure 9). The product obtained by multiplying these two pieces of data is an average population for the radial sector of interest. The populations within sectors are then aggregated for radial sectors of equal atmospheric concentration.

Several levels of effort are possible in enumerating populations around prototype point sources. The level of effort is determined by the available locational information for the point sources of interest. The population prototype can be developed with the following population density data:

1. Specific SMSA population densities.

2. Regional population densities.

3. National population density.

4. Regional or national population densities for Census defined geographic statistical categories (i.e., urban, metropolitan, and rural).

If the point sources of interest can be located according to SMSAs, the specific SMSA population density should be used to create the prototype. SMSA population densities can be obtained from the U.S. summary for Number of Inhabitants (Bureau of the Census 1983a) or General Population Characteristics (Bureau of the Census 1983b). Statistical Abstract of the U.S. (Bureau of the Census 1982b) also provides the land area and yearly updates of the population for each of the SMSAs in the U.S., from which up-to-date SMSA population densities can be calculated.

If the point sources of interest can be located only according to regions or if locational data are completely lacking, regional or national population densities can be used to calculate the average population in each of the ATM radial sectors. Population densities for regions and the U.S. are listed in Table 8.

If the location of the point sources can be determined according to the Census defined geographic statistical categories (e.g., urbanized, metropolitan (SMSAs), or nonmetropolitan), the population densities for each of these categories should be used to create a population prototype. To illustrate this approach, prototypes for sources located in urbanized, metropolitan, and nonmetropolitan areas have been created. This was accomplished as previously mentioned by calculating the land area of each radial sector defined by ATM and then multiplying the area by the respective population density of the geographic category. Population densities of 1,033 persons/km^2 for urbanized*, 120 persons/km^2 for metropolitan (SMSAs), and 8 persons/km^2 for non-metropolitan areas were used (Bureau of the Census 1981b). Results of these calculations are presented in Table 9. It is important to note that when the population prototypes for urbanized and metropolitan areas were calculated, the respective densities were only applied to the radial sectors within radial rings that correspond to the average radius of urbanized and metropolitan areas. The average radii of 8 km and 26 km for urbanized and metropolitan areas in the U.S., respectively, were calculated by dividing the total U.S. land area for each category by the number of areas in the U.S. of each (Bureau of the Census 1981b). This average area was assumed to equal the area of a circle in order to back-calculate the radius.

The enumeration of populations exposed to chemical substances released from prototype point sources known to be located in one of these statistical categories is now possible by using the results presented in Table 9. The population estimates for each radial sector should be linked to the ATM-calculated concentration estimates for each sector (or radial ring) of the prototype point source. Populations should then be summed for all sectors of equal concentration to estimate the total exposed population for each concentration. These results are then multiplied by the number of sources to calculate the total population exposure distribution in the U.S. Method 2-3 summarizes the basic procedural steps for enumerating populations around prototype point sources.

This procedure is an approach to enumerating populations exposed via inhalation to atmospheric concentrations of chemical substances released from point sources too numerous to deal with individually. Each exposure assessment for a chemical substance should have an approach tailored to the available information for the point sources and chemical substance of

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*Joel Miller, Populations Section, Bureau of the Census, personal communication with Douglas Dixon, Versar Inc., April 1983.

Table 8. Population Densities for the Different Census Bureau Area Classifications and Regions

Region/classification	Density (persons/km^2)
U.S.	25[1]
Metropolitan	120[1]
Nonmetropolitan	8[1]
Northeast	116[1]
Metropolitan	291[1]
Nonmetropolitan	27[1]
North Central	30[1]
Metropolitan	130[1]
Nonmetropolitan	11[1]
South	33[1]
Metropolitan	102[1]
Nonmetropolitan	15[1]
West	10[1]
Metropolitan	76[1]
Nonmetropolitan	2[1]
Urban	873[2]
In Urbanized Areas	1,033[2]
Central Cities	1,371[2]
Urban Fringe	840[2]
Other Urban	491[2]
Rural	7[2]

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[1] Bureau of Census, 1981a.

[2] Preliminary unpublished data based on 1980 Census and updated census geography from Joel Miller, Bureau of the Census, Population Section (763-7955).

Table 9. Average U.S. Population Size for ATM-SECPOP Concentration Sectors for General Point Sources Located in Urbanized, Metropolitan, and Nonmetropolitan Area

Distance of boundary arc from source, r (km)	Radial sector land area (km^2)	Radial sector population		
		Urbanized	Metropolitan	Nonmetropolitan
0.5	0.05	52[1]	6	1
1.0	0.15	155[1]	18	1
2.0	0.59	609[1]	71	5
3.0	0.98	1,012[1]	118	8
4.0	1.37	1,415[1]	164	11
5.0	1.77	1,828[1]	212	14
10.0	14.72	8,760[2]	1,770	118
15.0	24.53	2,940[3]	2,940	196
25.0	78.50	9,420[3]	9,420	628
50.0	367.97	4,067[4]	4,067[4]	2,944

[1] Sector population calculated using the density of urbanized areas of 1,033 persons/km^2.

[2] Sector population calculated using the density of urbanized areas of 1,033 persons/km^2 to a radius of 8 km and the metropolitan density of 120 persons/km^2 to the remaining area within 10 km.

[3] Sector population calculated using the metropolitan density of 120 persons/km^2.

[4] Sector population calculated using the metropolitan density of 120 persons/km^2 to a radius of 26 km and the nonmetropolitan density of 8 persons/km^2 beyond 26 km.

Method 2-3 Enumeration of Populations Exposed via Inhalation to Chemical Substances Released from Prototype Point Sources

Step 1 The materials balance or information on the production and use of a chemical substance will identify the number of point sources to be considered. The location of these sources should be further identified according to cities, SMSAs, regions, counties, or a Census defined geographic statistical category (e.g., urbanized, metropolitan, or non-metropolitan). Volume 2 of this series provides information on data bases, documents, and associations that may aid in locating point sources.

Step 2 Using generic emission characteristics and site-specific meteorological data stored in GEMS that is representative of conditions around a typical facility, perform an ATM run (see Method 2-2). Volume 2 of this series also provides detailed information on the development of prototype point sources. The GEMS Users Manual (GSC 1983) describes meterological data stored to support ATM simulations.

Step 3 Using population densities for the locations of the point sources (e.g., SMSAs, regions) or the data in Table 9, calculate or record the average population for each radial sector or within each radial ring (radial sector population X16). The population in each radial sector or ring should then be matched to the concentration or range of concentrations predicted for each radial sector or ring around the prototype point source. Populations should then be aggregated for all radial sectors or rings of equal concentration.

Step 4 Multiply the Step 3 results by the total number of point sources in the U.S. to enumerate the total exposed population at each concentration or possible range of concentrations.

interest. The approach should also be developed according to the level of detail required and should obviously be within the time, financial, and manpower constraints of the effort.

(2) Area Sources. Area sources are sources of atmospheric release of chemical substances so numerous that patterns of concentration can be efficiently analyzed only as a group. Area sources may be either stationary, such as home heating systems, or mobile, such as vehicles. The usual approach to modeling area source emissions is to assume that the emissions are uniformly distributed within a geographic area. Emission rates per unit area (or per capita, household, or vehicle) are estimated, and resulting concentrations for the geographic area are calculated using an appropriate area source model or algorithm. Volume 2 of this series provides details on procedures and models for the calculation of atmospheric concentrations resulting from area source emissions.

Enumerating the exposed population for area sources involves the acquisition of census data for the geographic area of interest. The most straightforward procedure, therefore, is to define the area according to census geography. Census geographic categories include urban areas, urbanized areas, Standard Metropolitan Statistical Areas (SMSAs), central cities, and rural areas; these categories were defined in Table 2. Table 10 summarizes the 1980 population count data for the major census geographic categories and for each of the four census regions in the U.S. Detailed population data for census divisions or for states are available in the summary documents for Number of Inhabitants and Population Characteristics of the U.S. These documents provide precise enumerations of populations based on decennial Censuses. Statistical Abstracts of the U.S., published yearly, also supplies population count data for many of the census categories. The population data in this document are based on the most recent Census and are updated yearly by Census Bureau projections.

The major problem with the use of census data to estimate populations around area sources is that no information is available on the differential levels of exposure to the populations residing in the geographic areas. Systems Applications, Inc. (SAI 1980) has presented a method of estimating differential exposures within geographic areas by distributing national area source emissions among different size cities (as determined by population) according to number of motor vehicles, heating day requirements, and population density. For detailed information, the investigator should consult the SAI document (SAI 1980). Unless finances and manpower are plentiful, the approach discussed in the preceding paragraph is an efficient procedure for enumerating populations exposed via inhalation to chemical substances released from area sources. Method 2-4 summarizes the required procedural steps.

Table 10. 1980 Population Data for the U.S. and Regions by Census Geography

		Region			
	U.S.	Northeast	North Central	South	West
Total Population	226,504,825	49,136,667	58,853,804	75,349,155	43,165,199
SMSAs	169,405,018	41,741,201	41,707,225	50,352,653	35,603,939
Central Cities	67,930,344	15,971,410	16,318,722	21,286,528	14,353,684
Outside Central Cities	101,474,674	25,769,791	25,388,503	29,066,125	21,250,255
NonMetropolitan Areas	57,099,807	7,395,466	17,146,579	24,996,502	7,561,260
Urban Areas	166,965,380	38,904,486	41,465,803	50,382,409	36,212,682
In Urbanized Areas	139,010,856	35,520,242	32,821,792	39,638,958	31,129,864
Other Urban	27,954,524	3,484,244	8,644,011	10,743,451	5,082,818
Rural Areas	59,539,445	10,232,181	17,388,001	24,966,746	6,952,517

Source: Personal communication between Mrs. McCoy of the Population Division, Bureau of the Census, and Amy Borenstein, Versar, Inc., July 1982.

Method 2-4. Enumeration of Populations Exposed via Inhalation to Atmospheric Concentrations of Chemical Substances Released from Area Sources

Step 1 Determine the demographic category and geographic location of the area source from the production, use, and environmental release data for the chemical substance. Demographic categories for which census data are available include:

- Urban Areas
  - urbanized areas
  - other urban areas

- Standard Metropolitan Statistical Areas
  - central cities
  - outside central cities

- Nonmetropolitan Areas

- Rural Areas

The nature of the source determines which category should be used to define the area. Urban areas or central cities may be of concern with respect to vehicular exhaust or dry cleaning solvents; rural locations may be area sources of pesticides used in farms and gardens.

Step 2 Enumerate the population for demographic and geographic category of interest from Table 10. If more detailed data are required (e.g., census division, state), retrieval of population data in MARF according to specific areas is possible using the GEODATA HANDLING (GH) operation and Census Data (CD) program of GEMS as previously described in subsection (1) and Method 2-2. Population data are also available in the the U.S. summary of Number of Inhabitants or General Population Characteristics. Statistical Abstract of the U.S. will also provide population data for many of the demographic categories listed, based on updates from the 1980 census year.

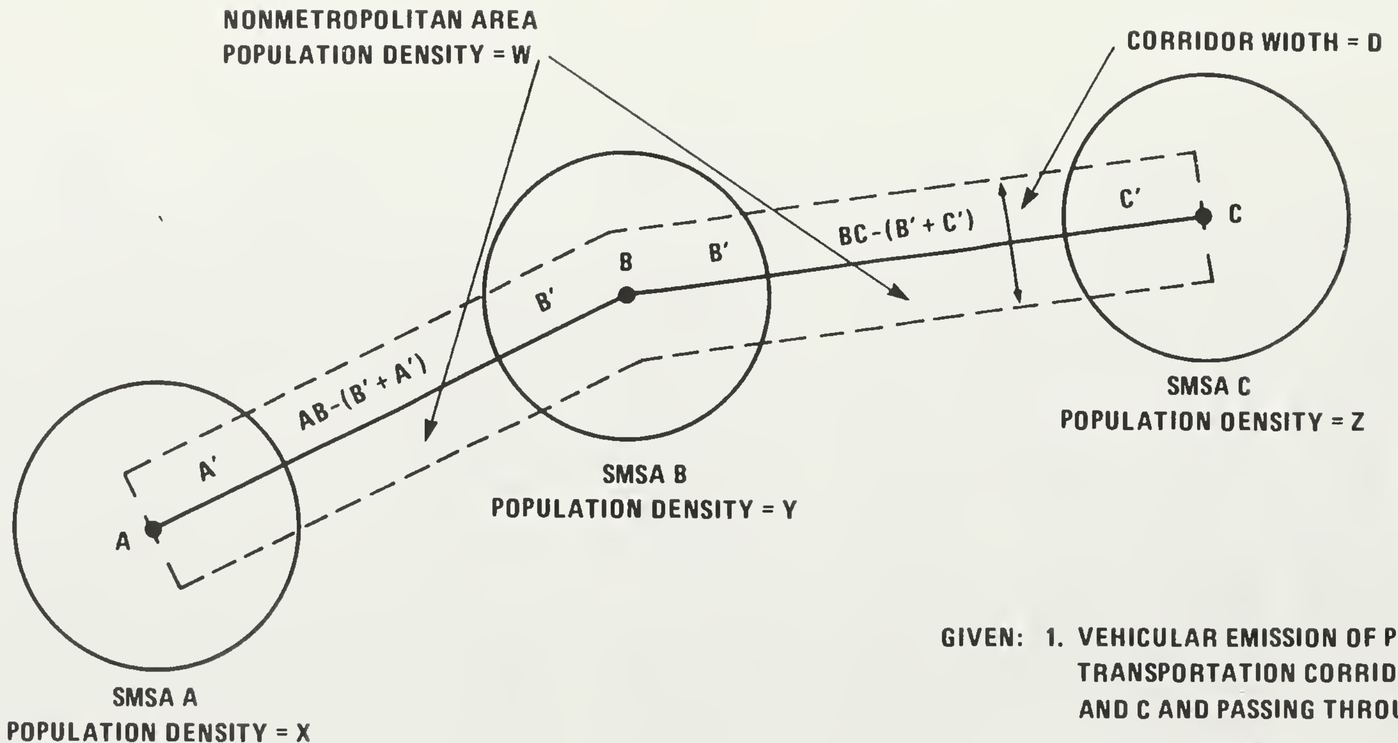
(3) Line Sources. This section presents a method for enumerating populations exposed to chemical substances released from line sources. As defined in Section 2.2, line sources are predominantly sources of airborne release of chemical substances along transportation corridors, such as highway and railroad lines. Other types of releases from line sources also exist, such as the volatilization of chemical substances from waterways and fugitive emissions or spills and leaks that occur along pipelines used to transport chemical substances. These types of releases are not specifically addressed in this section; however, the general principle of the methodology presented is applicable to them.

The only existing method identified for enumerating populations exposed to chemical substances released from a line source was developed for the U.S. Department of Commerce, Maritime Administration (ADL 1974). The method was developed to calculate the safety hazards resulting from different modes of transportation of hazardous substances. Basically, the method requires data on the length of the line source (or transportation corridor), the width of the area adjoining the line source affected by the release of the chemical substance, and the population densities along the line source. The total area affected by the chemical substance is calculated by multiplying the length and width of the affected area. Total area affected is then multiplied by population densities to enumerate the exposed population.

The method developed for the Maritime Administration assumes that all line sources of chemical release are straight lines that pass through metropolitan areas, nonmetropolitan areas, or combinations of both. Metropolitan areas are defined as those designated Standard Metropolitan Statistical Areas (SMSA) by the Census Bureau. Nonmetropolitan areas are defined as all areas outside SMSAs.

For a line source that begins and terminates in an SMSA, the following procedure for calculating the length of the line which passes through metropolitan and nonmetropolitan areas was developed:

The SMSA for each principal city along the origin-destination route is recorded in units of square miles according to census data. This area is then converted to a circular configuration with the principal city located at its center. If the line source (the vehicle or transportation corridor) travels completely through an SMSA, then the hypothetical diameter of each SMSA is assumed to be equivalent to the length of the metropolitan population corridor exposed to the chemical substance of interest. If the line source originates or terminates in an SMSA, then the length of the metropolitan population corridor is assumed to be equal to the hypothetical radius of the SMSA. The length of the nonmetropolitan population corridor, therefore, is equal to the total distance between the beginning and end of the line source minus the calculated length of the metropolitan population corridor. This procedure for calculating metropolitan and nonmetropolitan population corridor lengths is illustrated in Figure 15.


NONMETROPOLITAN AREA
POPULATION DENSITY = W
CORRIDOR WIDTH = D
A
A'
AB-(B' + A')
B'
B
B'
BC-(B' + C')
C'
C
SMSA A
POPULATION DENSITY = X
SMSA B
POPULATION DENSITY = Y
SMSA C
POPULATION DENSITY = Z

GIVEN:
1. VEHICULAR EMISSION OF POLLUTANT ALONG TRANSPORTATION CORRIDOR BETWEEN SMSAs A AND C AND PASSING THROUGH SMSA B.
2. LINE SOURCE WIDTH (D) DETERMINED FROM POLLUTANT EMISSION MODELING OF AMBIENT CONCENTRATION.

CALCULATIONS:
1. METROPOLITAN POPULATIONS
   SMSA A = A' x D x X
   SMSA B = 2B' x D x Y
   SMSA C = C' x D x Z
   TOTAL METROPOLITAN POPULATION = A + B + C
2. NONMETROPOLITAN POPULATIONS =
   AC - (A' + 2B' + C') x D x W
3. TOTAL POPULATION EXPOSED =
   TOTAL METROPOLITAN POPULATION +
   NONMETROPOLITAN POPULATION

SOURCE: ADAPTED FROM AOL 1974

NOTE: SEE APPENDIX A-1, PROBLEM 5 FOR DEMONSTRATION OF METHOD

Figure 15. Schematic Representation of the Procedure to Enumerate Populations Exposed to Chemical Substances Released From a Line Source

The width of the line source is defined according to an appropriate algorithm or model using emissions characteristics of the pollutant and meteorological conditions (wind speed, direction, and atmospheric stability). The total metropolitan area exposed is calculated as the product of the length and width of the metropolitan corridor. The same procedure is followed for calculating the total nonmetropolitan area exposed. The calculated areas are then multiplied by the average metropolitan (SMSA) and nonmetropolitan (non-SMSA) population density, respectively, to enumerate the total exposed population.

This procedure for enumerating populations exposed to chemical substances released from a line source is believed to be a suitable approach for the current needs of OTS-EED. One of the main data requirements of the ADL approach is the length of the line source. These data are generally provided on a chemical-specific basis in the exposure assessment process.

Detailed information on methods to calculate the length of line sources related to transportation spills is available in Volume 9 of this series. Statistical Abstract of the U.S. (Bureau of the Census 1982b) is also an excellent source on such generic data as metropolitan and non-metropolitan highway mileage, inter-city bus lines, and railroad mileage for the total U.S. and the individual states. For detailed geographic resolution, the topographic maps published by the U.S. Geological Survey are the recommended tool for obtaining the length of a particular line source. Since most of these maps also include plots of metropolitan and nonmetropolitan areas, it is also possible to rapidly determine the length of the line in each category.

Calculation of the width of the line source corridor requires the use of one of several line source simulation models. Line source simulation models consider emission characteristics and meteorological conditions to determine concentrations at various distances downwind of the source. Currently, OTS-EED does not have any line source models integrated into GEMS. The UNIVAC version of HIWAY is included in the EPA-OTS computer file library and, therefore, is available to the OTS-Modeling Team. Additional information on line source models is provided in Volume 2 of this series.

The final data requirement for enumerating the exposed population is the population density for the area of interest. Population densities for all SMSAs are available in the Census summary document Number of Inhabitants (PC-80-1-A). Population densities for cities with 100,000 or more inhabitants are available in Statistical Abstracts of the U.S. (Bureau of Census 1982b). Population densities for specific urban areas with populations less than 100,000 (but greater than 2,500) are available in the Census summary document General Population Characteristics (PC-80-1-B).

Finally, Table 8, previously presented, lists population densities for the different Census Bureau classifications based on 1980 Census data. The population densities obtained from the above listed documents or from Table 8 are then multiplied by the area of the line source corridor to enumerate the total population.

Method 2-5 summarizes the procedure for enumerating populations exposed via inhalation to chemical substances released from line sources. A demonstration of the method on a theoretical line source problem is presented in Appendix A-1 (Problem 5).

2.3.3 Enumeration of Populations Exposed via Dermal Contact

Dermal exposure to chemical substances in the ambient environment may occur through a number of pathways. One activity has been identified as having the greatest potential for significant exposure: swimming in contaminated surface waters. Methods for estimating the size of the population involved in that activity are presented in Method 2-6.

Approximately 101.7 million persons swim in U.S. surface waters (Bureau of the Census 1982b); this represents 45 percent of the U.S. population. The technique for estimating the number of swimmers contacting water contaminated by a particular substance depends on whether the exposure source was identified through monitoring data or through examination of the chemical's release information. Volume 2 of this series discusses identification of sources of chemicals released to surface water.

Geographically defined areas of aquatic exposure, such as river reaches downstream of an industrial discharge, may be identified by examining release information. The exposed population is therefore the swimmers in those specified receiving waters. The most reliable method for estimating the number of persons exposed to contaminants in surface waters is to contact regional authorities, such as the state, city, or county department of parks. These authorities can identify affected recreational areas and estimate the extent to which they are used.

Another approach to enumerating that population is to obtain a figure for the total population for the region using the water body as a source of recreation, then to multiply that total by 45 percent, the fraction of persons who swim. There are limitations to this estimation technique; determining the region that uses a recreational facility, such as a lake or river, is difficult. Matching that region to a census-defined geography for which population data are available may also present problems. If necessary, the area may be broken into block groups or

Method 2-5. Enumeration of Populations Exposed via Inhalation to Chemical Substances Released from Line Sources

Step 1 Calculate the length of the line source as illustrated in Figure 15. Sources of information on the calculation of the length of the line source include Volume 9 of this series Methods for Estimating Exposure to Chemical Substances Resulting from Transportation Related Hazardous Materials Spills and A Modal Economic and Safety Analysis of the Transportation of Hazardous Substances in Bulk (ADL 1974). Generic data for line source lengths can be obtained from Statistical Abstracts of the U.S. (Bureau of the Census 1982b) or from government agencies and associations such as U.S. Department of Transportation - Federal Highway Administration and Federal Railroad Administration; the U.S. Interstate Commerce Commission; Bureau of the Census - Transportation Surveys; Association of American Railroads, Washington, D.C.; American Bus Association, Washington, D.C.; and American Public Transit Association, Washington, D.C.

Step 2 Calculate the area affected by the released pollutant. This may be accomplished by calculating the width of the exposed corridor using an appropriate line source model. Data on the emissions characteristics and meteorological conditions are required for most of the available line source models. Exposed area is the product of the length of the line source and the corridor width.

Step 3 Enumerate population by multiplying the population density of the exposed area by the calculated area exposed (Step 2). Population densities for specific census divisions, states, and urban areas based on the 1980 Census are available in the Census Report General Population Characteristics: U.S. Summary. Population densities for SMSAs are available in the Census document Number of Inhabitants: U.S. Summary. Table 8 lists generic population density data that would also be valuable where detailed or specific data are not required. If more resolution is required for urban areas, population estimates can be refined by consulting maps of ED/BGs to determine which ones fall into the affected area. Populations can be summed for these ED/BGs to provide a more accurate estimate than that given by the product of area and average density.

Method 2-6. Enumeration of Populations Exposed via Dermal Contact

Determine the number of swimmers contacting contaminated ambient surface waters.

Option 1 - (contamination identified by monitoring data or release information) contact the local authorities to identify impacted recreational areas. Inquire about the area's use to estimate the number of affected persons.

Option 2 - (contamination identified by monitoring data). Multiply the frequency of detection in percent by the total population of swimmers, 101.7 million persons. (This option yields a very crude estimate of the exposed population. It assumes that the monitoring data are from a nationwide survey of all potential swimming locations or that they are from a sampling that is statistically representative of all swimming locations.)

Option 3 - (contamination identified by release information). Identify the water bodies of concern. Enumerate the total population within a 50 mile radius or corridor, using data in General Population Characteristics for census-defined geographies such as cities, towns, counties, or SMSAs. Multiply the total population of the area by 45 percent, the fraction of persons who swim in surface waters.

Option 4 - (contamination identified by monitoring data). If extensive nationwide monitoring data are available, they can be used to identify the affected water bodies. The procedure to enumerate the number of swimmers exposed to the chemical substance is the same as in Option 3.

enumeration districts, then reaggregated. It is reasonable to assume that a body of water within 50 miles of a person (a one-hour drive) may be used as a source of recreation. The investigator might assume that the population within that radius or corridor is potentially exposed. The General Population Characteristics for the area should be consulted, and the total population of counties, towns, SMSAs, etc., within the radius or corridor should be totaled.

For contaminants introduced by sources other than point discharges of effluents, geographic definition of potential exposure may not be possible. Monitoring data retrievals from STORET or similar data bases can then be used to indicate the prevalence of waterborne pollution for a chemical substance. If enough data are available, an estimate of the number of persons dermally exposed via swimming can be obtained by multiplying the frequency of detection of the contaminant in surface water (in percent) by the participating population (101.7 million persons).

These population enumeration techniques assume that persons will swim in contaminated waters as often as in noncontaminated lakes and rivers. Figures obtained by these methods may therefore be overestimates. That assumption is not, however, unreasonable; low level contamination that may cause human exposure is not always detectable.

2.3.4 Enumeration of Nonhuman Populations

Nonhuman populations are generally more difficult to quantify than are human populations because less information is available, and the data that are available are often measured in units other than numbers of organisms; populations may, for example, be expressed as herds or biomass. The adequacy and sources of nonhuman population data vary considerably, depending on the organism. As might be expected, most research effort has been invested in plant and animal species that have economic significance.

In most cases, it is necessary to gather the data from diverse sources to enumerate nonhuman populations. The major sources available include journal articles and other publications, federal and state agencies, and selected private agencies. A literature search, using computerized data bases such as the following, is recommended:

AGRICOLA (National Agricultural Library, Beltsville, MD)
AGRICOLA is the cataloging and indexing data base of the National Agriculture Library. It provides comprehensive coverage of worldwide journal and monographic literature on agriculture and related subjects.

ASFA (NOAA/Cambridge Scientific Abstracts, Bethesda, MD)
The Aquatic Sciences and Fisheries Abstracts (ASFA) is a comprehensive data base on life sciences of the seas and inland waters as well as related legal, political, and social topics. It includes information on aquatic biology, oceanography, fisheries, and water pollution.

BIOSIS PREVIEWS (Biosciences Information Service, Philadelphia, PA)
BIOSIS PREVIEWS provides comprehensive worldwide coverage of research in the life sciences. It contains citations from Biological Abstracts and Biological Abstracts/RRM.

Life Sciences Collection (Cambridge Scientific Abstracts, Bethesda, MD)
Life Sciences Collection contains abstracts of worldwide journal articles, books, conference proceedings, and report literature. The information includes animal behavior, ecology, and entomology.

SSIE Current Research (Smithsonian Science Information Exchange, Washington, D.C.)
SSIE Current Research contains reports of both government and privately funded scientific research projects either currently in progress or initiated and completed during the most recent two years.

These and other data bases can be accessed through DIALOG Information Retrieval Service (DIS 1982).

In addition to these data bases, a retrieval from the Fish and Wildlife Reference Service and a retrieval from the GEOECOLOGY Data Base may be worthwhile. The reference service is operated by the U.S. Fish and Wildlife Service out of Denver, Colorado. Computerized literature searches, covering the published and unpublished fish and wildlife research reports resulting from federally funded programs, are conducted for a fee of $30. The GEOECOLOGY Data Base (Olson et al. 1980), maintained by the Oak Ridge National Laboratory, Oak Ridge, Tennessee, is a compilation of computerized environmental data. The data base includes, at the county level of resolution, selected data on terrain and soils, water resources, forestry, vegetation, agriculture, land use, wildlife, and endangered species. The wildlife sector includes information from the annual Breeding Bird Survey, data on federally designated endangered and threatened species, and the geographic range of various mammals. The Endangered Species File and Code Dictionary of the GEOECOLOGY data base is currently available through the EPA-OTS computer library (Files W09 and W10, respectively). Requests for information or retrievals for the other data included in GEOECOLOGY should be directed to:

Dick Olsen
GEOECOLOGY Project Team
Oak Ridge National Laboratory
PO Box X, Building 1505
Oak Ridge, TN 37830
(615) 574-7819

Estimates of exposed nonhuman population sizes may also be made, if the resources permit, through contact with appropriate state and federal agencies. The two that are of most use are the Fish and Wildlife Service and the U.S. Department of Agriculture's Forest Service. Both maintain regional research offices which may provide published or unpublished population data not available from other sources. Private agencies such as those listed in Table 11 may also be contacted for population information. The National Wildlife Federation (1980) lists many private organizations with specific wildlife concern which may also be used as information sources.

The investigator should be aware that, for most species, the population data, if any, are scant and are based on a handful of studies in specific locales. Extrapolating such data to large regions or to the nation involves considerable uncertainty because uneven spatial distribution and temporal fluctuations are characteristic of many nonhuman populations. Population density is highly dependent on habitat type, and the population density estimated in one local study may be significantly higher or lower than the average population density for larger areas (e.g., counties, states, regions).

2.4 Characterization of Exposed Populations

The average physiological parameters that determine exposure (e.g., breathing rate, body weight, and skin surface area) are age- and sex-specific. Subpopulations defined by age or sex, such as the elderly or women of child-bearing age, may be especially susceptible to a chemical substance. Characterization of exposed populations permits the determination of exposure distributions and the enumeration of specific high risk subpopulations. Methods for characterizing populations exposed via inhalation and dermal exposure in the ambient environment are presented in the following subsections.

2.4.1 Populations Exposed via Inhalation

The level of geographic resolution necessary to an assessment of atmospheric pollutants dictates the scheme by which characterization proceeds. Populations near point sources for which ATM-SECPOP is used to determine exposure may be characterized by the use of census data

Table 11. Sources of Information on NonHuman Populations

National Wildlife Federation
1412 16th Street, NW
Washington, DC 20036
(202) 797-6800

National Audubon Society
950 Third Avenue
New York, NY 10022
(212) 832-3200

North American Wildlife Foundation
709 Wire Building
Washington, DC 20005
(202) 347-1775

Raptor Research Foundation, Inc.
c/o Richard R. Olendorff
Division of Resources
U.S. Bureau of Land Management
2800 Cottage Way
Sacramento, CA 95825

The Wildlife Society
Suite 611
7101 Wisconsin Avenue, NW
Washington, DC 20014
(301) 986-8700

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specific to the area. For prototype point sources, area sources, and line sources, both site-specific and generic data on the age and sex characteristics of the population may be applicable sources of information.

(1) Point Sources Enumerated by SECPOP. The SECPOP data base enumerates the populations differentially exposed in segments around point sources. Data for geographically-defined areas within the SECPOP radius are available from the Bureau of the Census.

Populations enumerated by SECPOP can usually be characterized by consulting the General Population Characteristics series for the area within the model radius. The level of detail achievable through this data source will be sufficient for all but the most in-depth exposure analyses; Table 2 (Section 2.3.1) lists the census-defined areas for which age and sex data are available from General Population Characteristics.

Segments within the model radius can also be segregated into census tracts if more detail is required. Series PHC80-2, Census Tracts, presents data by age and sex for populations defined by census tract.

(2) Point, Area, and Line Sources. The data sources discussed above (General Population Characteristics and Census Tracts) can be used to characterize populations around or within these pollutant sources. Point, area, and line sources are, however, often too numerous to be treated individually. Table 12 presents the age and sex distribution of the U.S. population as determined by the 1980 Census. These data may be used to estimate the distribution of males and females of different ages in relatively large exposed populations; that distribution would be expected to be similar to the national distribution. Method 2-7 is a guide to characterizing exposed populations.

2.4.2 Populations Exposed via Dermal Contact

Numerous activities in the ambient environment may lead to dermal contact with chemical substances: aquatic recreation, gardening and other contact with the soil, and contact with atmospheric pollutants deposited on the skin surface. Of these, one is considered to be a potentially significant source of exposure: swimming in contaminated surface waters.

As discussed in Section 2.3.4, a large proportion of the population swims in lakes, rivers, and the ocean. It can be assumed that such a large population constitutes a cross section of the U.S. populace and that swimmers can be characterized by the data in Table 12. It is likely that the actual swimming population is skewed somewhat toward the young, and that the young swim more frequently, but data to substantiate that premise are not available.

Table 12. Population of the United States by Age and Sex: April 1, 1980

Age and sex	Population	Percent
1. Both sexes		
All ages	226,504,825	100.00
Under 5	16,344,407	7.22
5-9	16,697,134	7.37
10-14	18,240,919	8.05
15-19	21,161,667	9.34
20-24	21,312,557	9.41
25-34	37,075,629	16.37
35-44	25,631,247	11.32
45-54	22,797,367	10.65
55-64	21,699,765	9.58
65-74	15,577,586	6.88
75-84	7,726,826	3.41
Over 85	2,239,721	.99
Median age	30.0	
2. Male		
All ages	110,032,295	100.00
Under 5	8,360,135	7.59
5-9	8,537,903	7.76
10-14	9,315,055	8.46
15-19	10,751,544	9.77
20-24	10,660,063	9.69
25-34	18,378,764	16.70
35-44	12,567,786	11.42
45-54	11,007,985	10.00
55-64	10,150,459	9.22
65-74	6,755,199	6.14
75-84	2,865,974	2.60
85 +	681,428	0.62
Median age	28.8	
3. Females		
All ages	116,472,530	100.00
Under 5	7,984,272	6.85
5-9	8,159,231	7.00
10-14	8,925,864	7.66
15-19	10,410,123	8.94
20-24	10,652,494	9.15
25-34	18,696,865	16.05
35-44	13,063,461	11.22
45-54	11,789,382	10.12
55-64	11,549,306	9.92
65-74	8,822,387	7.57
75-84	4,860,852	4.17
85 +	1,558,293	1.34
Median age	31.3	

Source: Personal communication between Mrs. McCoy of the Population Division, Bureau of the Census, and Amy Borenstein, Versar, Inc., July 1982.

Method 2-7. Characterization of Populations Exposed to Chemical Substances via Inhalation of Ambient Air

For populations near point sources (as enumerated by SECPOP), line sources, or area sources, choose the option providing the desired level of detail. The method of enumeration and the financial and manpower resources allotted will dictate the choice of options.

Option 1 - The most detailed characterization is obtained by determining census tracts within the defined radius, area, or corridor and using the age-sex distributions for each (in Census Tracts) to describe the population.

Option 2 - General Population Characteristics for the area (SMSA, county, town, etc.) provides the age and sex characterization for the enumerated population.

Option 3 - The generic data in Table 12, describing the U.S. population as a whole, may be used to characterize populations around point, general point, area, or line sources.

2.5 References

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3. POPULATIONS EXPOSED TO CHEMICAL SUBSTANCES IN THE OCCUPATIONAL ENVIRONMENT

3.1 Introduction

This section presents methods for enumerating and characterizing occupationally exposed populations. The methods described apply to workers in industry, trade, and commercial establishments. The data provide various levels of detail that enable the user to produce both preliminary and in-depth assessments.

Figure 16 is a flow diagram of the three-stage method framework. Included in the diagram are some of the major data sources used.

The identification of the exposed population is discussed only briefly in this section (Subsection 3.2); the occupational exposure assessment methods report (Volume 6) describe the process in detail.

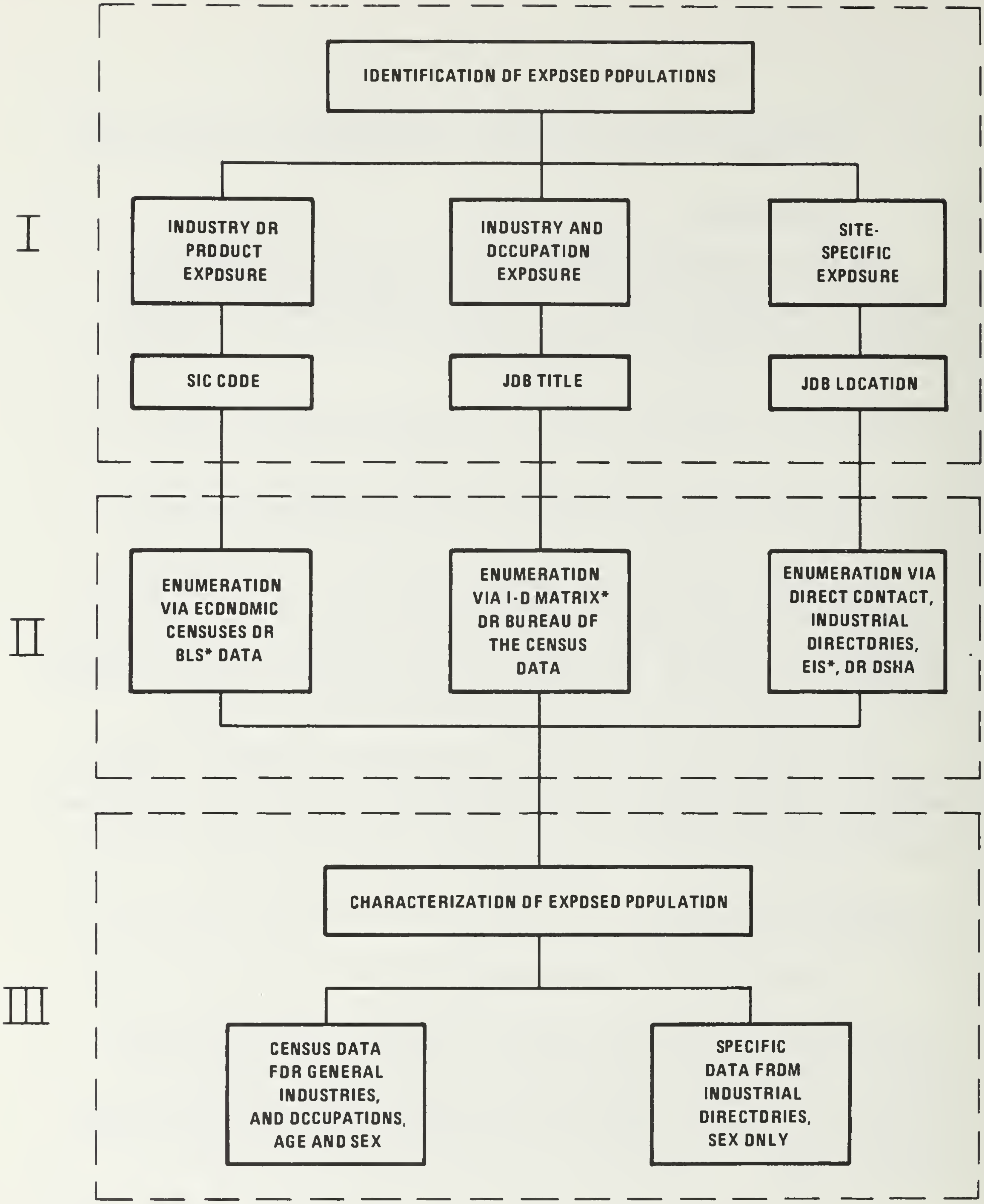
The enumeration of the exposed population relies on the direct utilization and combination of numerous data bases. This information is largely the result of efforts by the federal government to monitor employment; as such, the data may not be in a format directly applicable to exposure assessments. Subsection 3.3 addresses the limitations of the data and how they can be used for occupational population studies.

The age and sex of a worker affect physiological parameters that determine exposure (e.g., breathing rate, skin surface area). Detailed exposure assessments may require that populations be described by age and sex distributions; Subsection 3.4 discusses methods of characterizing workers by age and sex.

Examples of the use of the methods in this section of the report are presented in Appendix A-2.

3.2 Identification of Exposed Populations

Methods for identifying occupationally-exposed populations are summarized herein; Volume 6 of this series provides details on these methods. Specific job titles and 4-digit Standard Industrial Classification (SIC) designations are the most common forms by which employment is listed. Identification should be keyed to this fact when possible. Method 3-1 summarizes the general approach to population identification.


IDENTIFICATION OF EXPOSED POPULATIONS
I
INDUSTRY OR PRODUCT EXPOSURE
INDUSTRY AND OCCUPATION EXPOSURE
SITE-SPECIFIC EXPOSURE
SIC CODE
JOB TITLE
JOB LOCATION
II
ENUMERATION VIA ECONOMIC CENSUSES OR BLS* DATA
ENUMERATION VIA I-O MATRIX* OR BUREAU OF THE CENSUS DATA
ENUMERATION VIA DIRECT CONTACT, INDUSTRIAL DIRECTORIES, EIS*, OR OSHA
III
CHARACTERIZATION OF EXPOSED POPULATION
CENSUS DATA FOR GENERAL INDUSTRIES, AND OCCUPATIONS, AGE AND SEX
SPECIFIC DATA FROM INDUSTRIAL DIRECTORIES, SEX ONLY

*BLS = BUREAU OF LABOR STATISTICS
*I-O MATRIX = INDUSTRY-OCCUPATION MATRIX
*EIS = ECONOMIC INFORMATION SYSTEMS, INC.

Figure 16. Three-stage Framework for Enumeration and Characterization of Occupationally Exposed Populations

Method 3-1. General Procedure for Identifying Populations Exposed in the Workplace

Step 1 Determine which industries and types of establishments produce, process, use, and sell the chemical substance of concern. Locate major production and use facilities. Identify the applicable SIC codes for all industries and establishments (see Volume 6 of this series).

Step 2 Consult the production, use, and release information and available monitoring data to identify points of chemical release and possible exposure pathways and exposure routes. Identify activities leading to exposure (see Volume 6).

Step 3 For each industry and activity identified in Steps 1 and 2, list the workers potentially exposed by occupation or job title. Use the Industry-Occupation (I-O) matrix as a guide in listing.

Employees potentially exposed via inhalation, ingestion, and dermal contact may be identified by examining workplace monitoring data or by considering the workers' process equipment and job activities.

Monitoring data are usually available only for a relatively small number of existing chemicals. New chemicals must be investigated by studying the premanufacturing notice (PMN) submittal and supplementing that information with knowledge of the process. Analysis of monitoring data and production, use, and release information may identify:

- Workers exposed in a particular industry, identifiable by SIC code.
- Persons employed in a specific occupation in an industry.
- Workers exposed by their presence at an industrial site.
- Persons performing certain activities or processes not directly classifiable by occupation (e.g., cleaning, sampling, waste disposal).

These groups are enumerated by methods specific to each. The following section discusses the methods by which exposed populations can be enumerated. Most of the methods rely upon direct use of data bases maintained to monitor employment levels. As mentioned previously, the data may not match the identified populations; adaptation of the information is discussed.

3.3 Methods for the Enumeration of Exposed Populations

This section presents the recommended procedures and data sources for the enumeration of occupationally-exposed populations. The methods may often be used in combination with each other to achieve the best estimate of workers exposed to chemical substances, though common sense must be used to avoid double-counting subpopulations. The method or methods to be used are often dictated by the identification scheme.

This section is divided into three subsections, based on the categories for identifying the exposed populations. Subsection 3.3.1 discusses data bases and methods based on the Standard Industrial Classification (SIC) codes. Populations identified by occupation and industry are discussed in Subsection 3.3.2, and Subsection 3.3.3 deals with site-specific worker populations.

Some of the methods discussed in this section provide better estimates than others. The greater the level of detail available, the better the estimate of the exposed population; thus, the methods based on specific occupation by industry or activity data are generally better than the SIC-based method. The limitations of each type of data are discussed in each section. Examples of the data available for many of the methods are included as Appendix B to this report. Appendix A-2 presents examples of applying the methods in this section.

3.3.1 Enumeration of Populations Identified by SIC Code

The method for enumerating workers identified by SIC code (Method 3-2) is straightforward and relies on the use of two types of information: (1) the Bureau of Labor Statistics' Employment and Earnings (U.S. Department of Labor 1981a) and (2) the Economic Census and related reports.

All SIC-based data have one major limitation. An establishment may be involved in activities classifiable under numerous 4-digit SIC codes, but all data are reported under one SIC designation (the "major activity" in which the company is involved). This provision simplifies a company's reporting requirements but produces data that may be gross underestimates or gross overestimates when used for exposure assessments. There is no way to account for such discrepancies in occupational population studies.

Another limitation has varying effects on the reported data. Some industries count only paid employees; establishments staffed by unpaid family members or owner-proprietors will therefore be uncounted or undercounted.

A problem with all SIC-based data is the lack of completeness. The list of 4-digit SIC codes runs nearly 80 pages of print, but data are reported for only a fraction of the established 4-digit codes. Some publications are limited by choice, i.e., only specific codes are reported. More often the limitation is related to the need to preserve confidentiality of responses when few data are reported for an industry.

(1) Employment and Earnings. The U.S. Department of Labor's Bureau of Labor Statistics (BLS) publishes Employment and Earnings monthly. The data therein are thus the most recent available; the employment figures in each publication are for the previous month.

The major limitation in the monthly BLS data is the lack of completeness. Only a fraction of the 4-digit SIC codes in manufacturing industries is represented, and nonmanfacturing industries (such as trade, construction, and services) are present at the 3-digit level of resolution at best. Use of data based on the 2- or 3-digit level may result in overestimation of occupational populations, because the broad categories may include industries in which no exposure occurs.

Method 3-2. Enumeration of Populations Identified by SIC Code

Step 1 Determine which source(s) list populations for the SIC codes for which data must be obtained. For nationwide chemical assessments, consult (in order of preference):

- Employment and Earnings (most recent data)
- The Economic Censuses (fairly complete and readily available)
- Other information such as County Business Patterns and the Annual Survey of Manufactures
- When enumerating populations in specific geographic areas, consult County Business Patterns (published last in 1981) or the Geographic Series of the Economic Censuses (accessible in hard copy or through GEMS).

Step 2 Choose the data most representative of the workers actually exposed. In manufacturing industries, for example, "production workers" is generally a better category for estimating exposures during the process than is total employment for a SIC listing (which includes office workers who may not be exposed).

Step 3 Qualify all data by addressing questions of limitations:

- Does the SIC code represent the exposed population? If not, are data overestimates or underestimates?
- Are data based only on paid employees and therefore possibly underestimates?

The BLS establishment data are number of jobs, not number of workers. If a person holds two jobs, he may be reported twice in Employment and Earnings. This, however, is rarely a limitation to the data as they are used in exposure assessments; only workers with both jobs classified under the same SIC code would be double counted in the exposed population for an occupation.

(2) Economic Censuses. Eight Economic Censuses are conducted in five-year cycles:

1. Census of Service Industries
2. Census of Wholesale Trade
3. Census of Retail Trade
4. Census of Manufactures Years ending in 2 and 7
5. Census of Mineral Industries
6. Census of Construction Industries
7. Census of Transportation
8. Census of Agriculture - Years ending in 8 and 3

All of the censuses contain information on employment, listed by SIC code. More information on the censuses is available from the Research Triangle Insitute (RTI 1982) and U.S. Department of Commerce (USDC 1979); detailed information on the compilation techniques is presented in the Census publications associated with each Economic Census. The data available in the first six economic censuses are summarized in Table 13. The Census of Transportation's only employment data are listings of truckers "for hire" and "not for hire" (RTI 1982).

Data related to the Economic Censuses include County Business Patterns and the Annual Survey of Manufactures. The County Business Patterns, last compiled in 1977, provide county-by-county and national summary statistics by SIC code for the full range of 2-, 3-, and 4-digit classifications. The reporting requirements and resulting data are similar to those of the Economic Censuses. The Annual Survey of Manufactures is a yearly update of the Census of Manufactures.

Despite their limitations, SIC-based data have proved useful in exposure assessments. This is especially true for widely used chemicals, such as formaldehyde in textile resins. Data from the Census of Manufactures provided useful estimates of textile mill workers exposed to formaldehyde, and the Censuses of Retail Trade and Wholesale Trade were used to enumerate persons exposed as a result of selling formaldehyde-treated cloth and apparel (Versar 1982).

All SIC-based employment data are government-generated and are therefore available to the public. All publications listed in this

Table 13. Data Available in the 1977 Economic Censuses

Census	Number of establishments		Employment			Reports available			Tapes	
	All	With payroll	All	Paid	Production/ construction	Geographic area[a]	Subject series[b]	Industry series[c]	Geographic areas	Industry series
Service industries	x	x		x		53	10	n/a	x	x
Wholesale trade		x		x		52	3	n/a	x	x
Retail trade	x	x		x		52	2	n/a	x	x
Manufactures		x	x*		x	51	17	82	x	x
Mineral industries		x	x*		x	9	8	14	no	no
Construction industries	s	s	s		s	10	n/a	28	no	no

n/a = not applicable.
x = Data available for all census areas down to counties and cities.
s = Data available at the state and national levels only.
* = Separate listings for office and administrative workers available.
[a] Reports data by state and nationally.
[b] Grouped into volumes of related types of businesses for convenient cross-referencing.
[c] Each report deals with one industry.

Source: Adapted from RTI (1982) and USDC (1979).

section can be obtained through the Government Printing Office, and many are available in major D.C. area libraries. The Modeling Team of the Exposure Evaluation Division's Chemical Fate Branch has begun incorporating the Economic Censuses into the Graphical Exposure Modeling System (GEMS). GEMS users can extract data for 3- or 4-digit SIC codes from the Geographic Series of the Censuses of Manufactures, Retail Trade, Wholesale Trade, and Service Industries. Total employment, number of establishments, and (where applicable) production workers can be obtained as national totals or by states, counties, SMSAs, or cities. These data can be statistically analyzed and displayed by GEMS in tabular form or in a variety of graphical presentations (e.g., bar graphs and scatterplots).

3.3.2 Enumeration of Populations Defined by Occupation and Industry

Occupationally exposed populations will often be identified by job title, e.g., by occupation and industry. The most detailed employment information available, the Industry-Occupation (I-O) matrix (U.S. Department of Labor 1981b), is presented in this format. The Bureau of the Census also presents data in that style, though at a much more aggregated level reflecting less detail than the I-O matrix. A third source of this form of occupational data is contact with professional organizations and trade associations. The use of these data is summarized as Method 3-3. Each type of information is discussed below.

(1) The Industry-Occupation (I-O) Matrix. The I-O matrix is a compilation of data collected regularly from the Bureau of Labor Statistics (BLS), state employment agencies, and the Employment and Training Administration of the Department of Labor. The matrix is collated for data in three-year cycles (RTI 1982). The data are actually presented as two matrices encompassing 1,615 occupations in 378 industries. One matrix lists industries by occupation; the printed output of this matrix is about 2,500 pages. The more useful listing of occupations by industry is 5,000 pages long. Both are available on computer tape from BLS; they can be obtained as paper hardcopy and on microfiche from the National Technical Information Service (NTIS). An example of the I-O matrix output is contained in Appendix B-1.

Personnel at the Bureau of Labor Statistics indicate that the publicly-available I-O matrix may be somewhat reduced in scope from its initial conception.* The effect of those changes on the usefulness of the data cannot be projected at this time.

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*Personal communication with G. Schweer, Versar, and E. Abramson, BLS, Division of Occupational Outlook, May 1982.

Method 3-3. Enumeration of Populations Identified by Occupation and Industry

Option 1	Consult the I-O matrix directory, and enumerate populations listed therein. Employment is read directly off the matrix; no adjustment or extrapolation is necessary.
Option 2	For very specific or unusual occupations, identify the applicable trade or professional organizations. Contact the organization and ask whether data on the number of member's is representative of total employment in that field.
Option 3	In the absence of all other data, estimate the population by consulting Occupation by Industry. If possible, state qualitatively whether the 1970 data provide overestimates or underestimates (more likely).

(2) Bureau of the Census data. The decennial Census collects detailed employment information from one in six respondents for publication as the Occupation by Industry series report (Bureau of the Census 1972). The biggest limitation to the use of the data is that they were last published in 1972, as a result of the 1970 Census. Budget limitations may preclude the publication of Occupation by Industry for the 1980 Census. Data collected in 1980 have not yet been programmed; publication or availability of tapes prior to 1984 is unlikely.[†] Any data derived from the 1970 Census must be used with caution.

(3) Contact with professional organizations and trade associations. Often the most precise and up-to-date employment figures can be obtained by contacting the organization representing a trade or profession.

The following references are useful in locating the relevant organization:

- Gale's Encyclopedia of Associations (Gale Research 1980)

- D.C. area telephone directories

The association staffer should be informed of the reason for the request, so that he or she can provide the most applicable estimate. Data limitations to be aware of include the possibility that retired or inactive members no longer involved in the occupation are still listed, or that the membership lists are simply out-of-date.

3.3.3 Enumeration of Site-Specific Populations

Exposure assessments requiring enumeration of workers at specific production facilities may be undertaken by using Method 3-4. This method relies on four sources of information:

1. Economic data (such as the Economic Information System - EIS - computerized data and printed reports)

2. The State Industrial Directories (State Industrial Directories Corp. 1979)

3. Direct contact with producers

4. State and federal OSHA inspection data.

[†] Personal communication between G. Hendrickson, Versar, and P. Vines, Bureau of the Census, December 1982.

Method 3-4. Enumeration of Site-Specific Populations

Option 1 (Direct Enumeration)

Step 1 Determine total employment at plant.

- Option 1: Retrieve data from EIS. The Line-of-Business reports, available for major manufacturers, list the locations and total employment for facilities.
- Option 2: Consult the State Industrial Directory. Facilities are listed by city in each state's volume.
- Option 3: Directly contact the manufacturer.

Step 2 Estimate the proportion of total employees involved in production of the chemical in question.

Option 2 (Extrapolation of Sample Data)

Step 1 Retrieve OSHA inspection data for the chemical substance. Inspections will list the number of workers affected at each plant site.

Step 2 Calculate the average number of workers exposed per plant for each type of facility (production, processing, etc.).

Step 3 Multiply the average per plant by the total number of plants nationwide to enumerate the total occupational population.

Note: The limitations to the use of Option 2 are described in Section 3.3.3.

The method can use any or all of the sources above, but it is best applied to enumerating a limited number of populations; direct enumeration of this type may be expensive and time-consuming. While the data from these sources are reliable, it is often difficult to ascertain what proportion of workers in a large plant are involved in the production of the chemical substance of interest. Extrapolation of data from a few plants to obtain national employment estimates is possible. There are limitations to the use of sample data. Unless inspections are (1) representative of industry-wide conditions and (2) complete (i.e., all exposed workers in each plant were identified), data from extrapolation may be inaccurate. An additional problem is that the majority of inspections are several years old, and few OSHA inspections are now done each year.

The Economic Information System (EIS) is a comprehensive computer data base listing a company's facilities and the number of employees at each site. The data are, however, expensive to retrieve ($90 per hour online); the usefulness of the EIS is therefore restricted. Data can be obtained through the Control Data Corporation's Economic Business Information System (EBIS) or by phone or mail contact:

Economic Information Systems, Inc.
310 Madison Avenue
New York, N.Y. 10017
(212) 697-6080

The State Industrial Directories Corporation publishes a state-by-state listing of industrial facilities, arranged by city. The Directory is published annually and is available in major libraries. The level of detail reported varies by state; some states record total employment, while some distinguish between office and production workers and characterize the workers by sex. The data recorded in the Directory may, however, be incomplete since all information is supplied to the Corporation voluntarily (State Industrial Directories Corp. 1979).

States and smaller government units may also publish their own directories in an effort to attract business. State Departments of Commerce and local Chambers of Commerce are good sources of information. Contacting a producer directly, either by mail or telephone, often produces the most recent and detailed data on workers.

As mentioned previously, one production facility may process any number of chemicals. Knowledge of the total employment at that plant provides only an upper limit for estimating the exposed worker population. Assuming that production techniques for different chemicals are equally labor intensive, the following may provide an order-of-magnitude estimate of the number of workers involved in the production of one chemical:

$$\frac{PV_a}{PV_t} = \frac{E_a}{E_t}$$

where

PV_a = the production volume of the chemical being assessed

PV_t = total production at the facility

E_a = employees producing the chemical being assessed (the exposed population), and

E_t = total plant employment.

3.4 Characterization of Occupationally Exposed Populations

Method 3-5 summarizes the characterization of occupationally exposed populations. Physiological differences between workers of both sexes and various ages may affect chemical exposure or the resultant risk. The most recent data on the distribution of the work force between men and women are presented in Table 14; the relevant "percent of total employment" figures can be applied to the enumerated population.

Table 15 presents the age and sex distributions for major occupational groups. These data are based on the 1970 Census, however, and they should be used with caution. Economic and social evolution of the past decade has produced changes that are readily apparent to one who compares Tables 14 and 15. Women once accounted for less than 17 percent of the managers and administrators; in 1979, over 30 percent of that group were women.

The State Industrial Directory series discussed in Section 3.3.3 may also provide the number of male and female workers at specific locations, but those data are only collected for a few states.

Method 3-5. Characterization of Occupationally Exposed Populations

Step 1 Determine whether age and sex characterization or sex characterization is required.

Step 2 Characterize the population. Apply percent distributions to the enumerated population.

Option 1: (Age and Sex.) Consult Table 15 for data on general occupations. Be cognizant that data are 12 years old.

Option 2: (Sex only.) Consult Table 14 for 1979 data on general and specific occupations.

Option 3: (Sex only.) Consult data derived from site-specific sources (see Section 3.3.3).

Table 14. Employed Persons by Occupation and Sex, 1979

Occupation	Percent of total employment	
	Male	Female
Professional and technical workers	46.0	54.0
Medical and other health	25.2	74.8
Teachers except college	20.6	79.4
Other	64.5	35.5
Managers and administrators, non-farm	68.1	31.9
Salaried	67.5	32.5
Self-employed, retail trade	62.1	37.9
Other self-employed	78.6	21.4
Sales workers	45.9	54.1
Retail trade	31.5	68.5
Other	65.1	34.9
Clerical workers	17.3	82.7
Stenographers, typists, secretaries	1.4	98.6
Other	22.9	77.1
Craft workers	92.6	7.4
Carpenters	100.0	-
Construction craftsworkers	98.9	1.1
Mechanics and repairers	98.2	1.8
Metal craftsworkers	95.1	4.9
Blue collar supervisors	85.7	14.3
All other	80.0	20.0
Operatives, except transport	51.7	48.3
Durable goods manufacture	57.6	42.4
Nondurable goods manufacture	36.4	63.6
Other industries	55.5	44.5
Transport equipment operators	91.0	9.0
Drivers, motor vehicles	90.1	8.9
All others	96.4	3.6
Non-farm laborers	87.0	13.0
Construction	95.3	4.7
Manufacturing	81.8	18.2
Other industries	86.4	13.6

Table 14. (continued)

Occupation	Percent of total employment	
	Male	Female
Private household workers	1.1	98.9
Service workers, except private household	36.5	63.5
Food service	29.8	70.2
Protective service	85.7	14.3
All other	32.7	67.3
Farmers and farm managers	86.1	13.9
Farm laborers and supervisors	73.3	26.7
Paid	78.8	21.2
Unpaid family	33.6	66.7

Source: Adapted from BLS (1980).

Table 15. Age and Sex Distribution of Employment by General Occupation

Occupation	Total number of persons employed	% of work force	Percent of total employed in each category									
			Males					Females				
			All	16-24	25-44	45-64	65	All	16-24	25-44	45-64	65
Professional, technical, and kindred	11,451,868	14.9	60.0	7.2	33.5	16.9	2.0	40.0	7.5	18.3	12.7	1.4
Managers and administrators, non-farm	6,386,977	8.3	83.4	4.4	38.0	36.9	4.1	16.6	1.3	5.9	8.3	1.1
Sales workers	5,432,778	7.1	60.6	10.0	25.7	21.2	3.7	39.4	9.4	11.9	15.9	2.2
Clerical workers and kindred	13,782,783	17.9	26.4	6.3	10.4	8.6	1.1	73.6	22.4	27.8	21.7	1.7
Craftsmen and kindred	10,638,804	13.9	95.1	11.4	44.1	36.8	2.8	4.9	0.7	2.0	2.0	0.2
Operatives, except transport	10,515,834	13.7	60.9	13.8	26.1	20.4	1.4	39.1	6.2	16.1	15.0	1.1
Transport operatives	2,954,932	3.8	95.5	15.0	45.1	32.9	2.4	4.5	0.6	2.5	1.4	0.1
Laborers, except farm	3,430,637	4.5	91.8	31.4	30.8	26.2	3.4	8.2	2.1	3.1	2.7	0.3
Farm workers	2,388,819	3.1	90.2	13.4	27.7	38.9	10.2	9.8	1.6	3.6	3.9	0.6
Service workers	9,821,739	12.8	39.5	9.8	12.8	13.8	3.0	60.5	13.5	20.6	22.9	3.5
ALL OCCUPATIONS	76,805,171	100.0	62.1	10.4	27.1	22.0	2.6	37.9	8.7	14.5	13.2	1.4

Source: Adapted from Bureau of the Census (1972).

3.5 References

BLS. 1980. Bureau of Labor Statistics. Handbook of labor statistics. Washington DC: U.S. Department of Labor. BLS Bulletin 2070.

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U.S. Department of Labor. 1981b. The national industry-occupation employment matrix, 1970, 1978, and projected 1990. Volumes I and II. Washington, DC: Bureau of Labor Statistics. Bulletin No. 2086.

Versar. 1982. Exposure assessment for formaldehyde. Draft Report. Washington, DC: U.S. Environmental Protection Agency, Office of Toxic Substances. Contract No. 68-01-6271.

4. POPULATIONS EXPOSED TO CHEMICAL SUBSTANCES VIA THE INGESTION OF FOOD

4.1 Introduction

This section presents methods for enumerating and characterizing populations exposed to chemical substances via the ingestion of food. The methods described are applicable to food items or categories of foods that contain chemical substances as a result of (1) agricultural practices (e.g., use of pesticides, fertilizers), (2) processing (e.g., packaging, canning), (3) contaminants that can be traced to point, area, and line sources, and (4) contaminants of unknown origin detected via monitoring data.

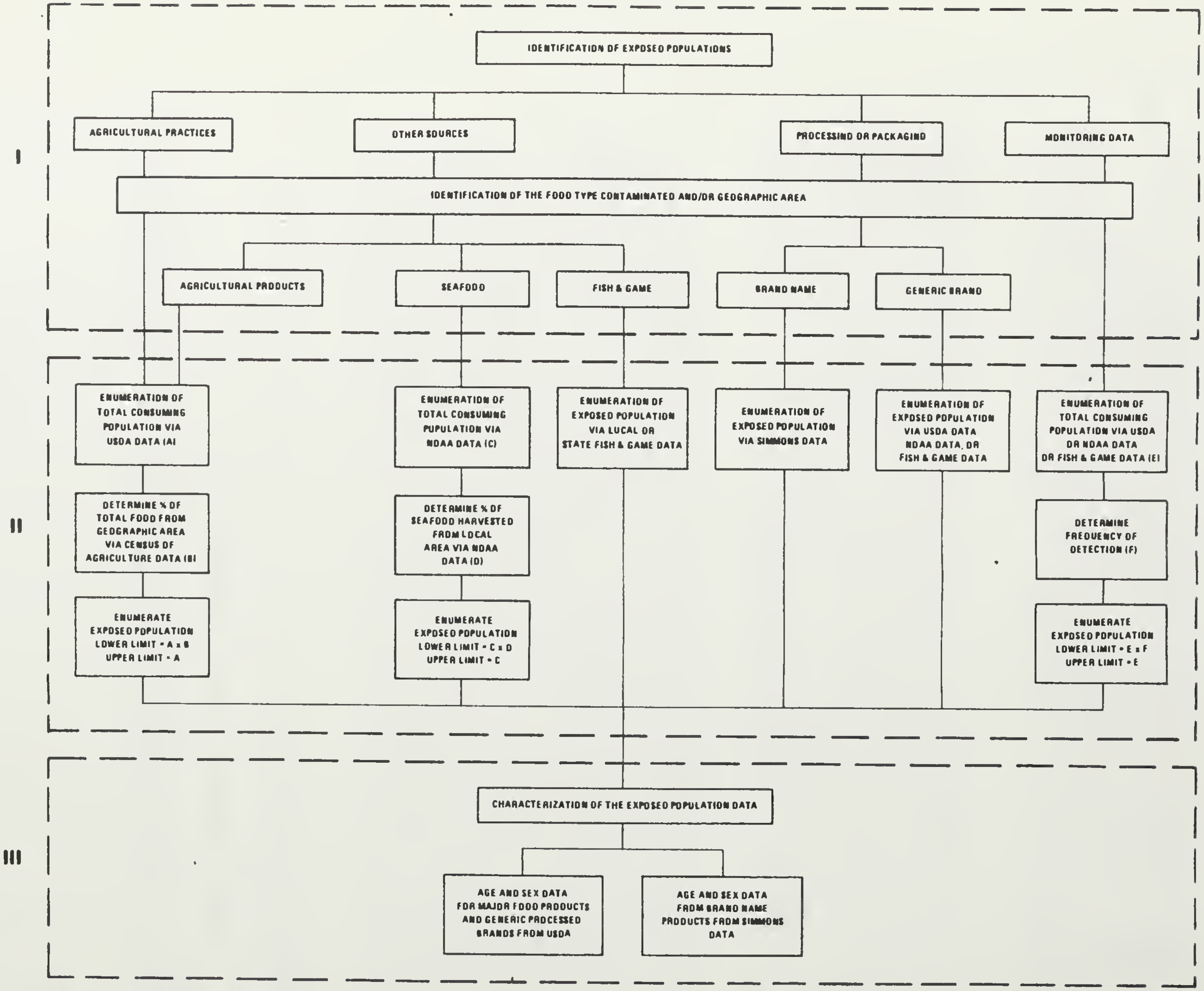
The methods that follow rely in many cases on simplifying assumptions in order to enumerate the exposed populations; foods and food products have geographical distributions and processing patterns that fluctuate depending on seasonal demand and availability. Enumeration of the total consuming population for a specific food is a relatively straightforward process. The exposed population is, however, some fraction of the consuming population; that fraction is a function of the source of the chemical substance. The methods presented in this section can be used to estimate the range of the exposed population.

Figure 17 is a flow diagram of the three-stage framework for enumerating and characterizing populations exposed to chemical substances via the ingestion of food. Each stage is composed of several methods depending on the source of the exposure or how the exposed population is identified in the exposure assessment. Subsection 4.2 briefly describes the procedures for identifying the exposed population. The enumeration of the exposed population is the second stage and is discussed in Subsection 4.3. Subsection 4.3 is organized according to the source of the chemical substance as illustrated in Figure 17. The third stage, characterization of the exposed population by age and sex distribution, is the subject of Subsection 4.4. This stage would only be used if it were determined that a chemical substance had a specific effect on a particular age or sex group or that a particular group was more highly exposed.

Examples of the use of the methods in this section of the report are presented in Appendix A-3.

4.2 Identification of Exposed Populations

Exposed populations can be identified either through knowledge of the sources of chemical contamination or by examination of monitoring data.


I
II
III
IDENTIFICATION OF EXPOSED POPULATIONS
AGRICULTURAL PRACTICES
OTHER SOURCES
PROCESSING OR PACKAGING
MONITORING DATA
IDENTIFICATION OF THE FOOD TYPE CONTAMINATED AND/OR GEOGRAPHIC AREA
AGRICULTURAL PRODUCTS
SEAFOOD
FISH & GAME
BRAND NAME
GENERIC BRAND
ENUMERATION OF TOTAL CONSUMING POPULATION VIA USDA DATA (A)
DETERMINE % OF TOTAL FOOD FROM GEOGRAPHIC AREA VIA CENSUS OF AGRICULTURE DATA (B)
ENUMERATE EXPOSED POPULATION LOWER LIMIT = A x B UPPER LIMIT = A
ENUMERATION OF TOTAL CONSUMING POPULATION VIA NOAA DATA (C)
DETERMINE % OF SEAFOOD HARVESTED FROM LOCAL AREA VIA NOAA DATA (D)
ENUMERATE EXPOSED POPULATION LOWER LIMIT = C x D UPPER LIMIT = C
ENUMERATION OF EXPOSED POPULATION VIA LOCAL OR STATE FISH & GAME DATA
ENUMERATION OF EXPOSED POPULATION VIA SIMMONS DATA
ENUMERATION OF EXPOSED POPULATION VIA USDA DATA NOAA DATA, OR FISH & GAME DATA
ENUMERATION OF TOTAL CONSUMING POPULATION VIA USDA OR NOAA DATA OR FISH & GAME DATA (E)
DETERMINE FREQUENCY OF DETECTION (F)
ENUMERATE EXPOSED POPULATION LOWER LIMIT = E x F UPPER LIMIT = E
CHARACTERIZATION OF THE EXPOSED POPULATION DATA
AGE AND SEX DATA FOR MAJOR FOOD PRODUCTS AND GENERIC PROCESSED BRANDS FROM USDA
AGE AND SEX DATA FROM BRAND NAME PRODUCTS FROM SIMMONS DATA

USDA = U.S. DEPARTMENT OF AGRICULTURE
NOAA = NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
SIMMONS = SIMMONS "MIRROR OF AMERICA" MARKETING REPORTS

Figure 17. Three-stage Framework for the Enumeration and Characterization of Populations Exposed to Chemical Substances via the Consumption of Food

The former is a "materials balance" approach and comprises three types of sources identifiable by an examination of a substance's use and release information:

1. Sources that result from agricultural practices (e.g., pesticide application, fertilization, growth hormones).
2. Sources related to processing and packaging procedures (e.g., contaminants introduced during canning, contaminants in food preservatives, leaching of contaminants from packing).
3. Other identifiable sources (e.g., ocean dumping, industrial effluents, contamination of animal feed during industrial processing).

Monitoring data may identify food items with contamination of unknown origin. The "Market Basket Surveys" of the Food and Drug Administration (DHEW 1975) are examples of monitoring data surveys that may identify contaminated food items, the consumers of which are the exposed population.

Comprehensive population identification must consider all three source types as well as available monitoring data. This identification will be conducted on a chemical-specific basis in the exposure assessment process. The general procedure for identification is presented in Method 4-1.

4.3 Methods for the Enumeration of Exposed Populations

Enumeration of the population eating a particular food item is straightforward; however, only a fraction of that population may consume contaminated food. Information on the geographic distribution of food items following harvest and packaging or processing is not available. Consequently, enumeration of the actual exposed population is not possible. Estimation of the population range in which the actual exposed population exists, however, is possible. The upper limit of the population range is equal to the total population that consumes a food item. The lower limit of the population range, based on the assumption that the consuming population is directly proportional to the quantity of the food item contaminated, can be estimated by multiplying the upper limit of the range by the percentage of the food item contaminated (e.g., the percentage of the food item grown in a particular geographic area, raised by a particular agricultural practice, processed or packaged by a particular procedure). The data bases and information sources that provide data and the methods to calculate the exposed population range are discussed in the following subsections according to the categories for identifying the exposed populations.

Method 4-1. Generalized Procedure for Identifying Populations Exposed to Chemical Substances via the Ingestion of Food

Step 1	Obtain all available monitoring data for the substance being assessed. Monitoring data for food items provide positive identification of exposure; the population that consumes the food item is an exposed population.
Step 2	Examine the uses of the substance being assessed. If it is used in an agricultural practice, the food items on which it is used may be contaminated. If it is used in a food processing procedure or in a packaging material, the food items processed or in contact may also be contaminated; the population that consumes the potentially contaminated food item is an exposed population.
Step 3	Examine the sources of the substance in the ambient environment. Knowledge of these sources, coupled with knowledge of the fate and transport of the substance in the environment, leads to the identification of the potentially contaminated food item; the population that consumes the food item is an exposed population.

4.3.1 Enumeration of Populations Exposed as a Result of Agricultural Practices

Enumeration of the population exposed to a chemical substance as the result of consuming a food item contaminated from an agricultural practice requires two steps. The investigator must first ascertain the size of the population that consumes the food item. This is the upper limit of the range of the exposed population. The percent of the total quantity of the food item that is produced via a specific agricultural practice must then be determined. This percentage multiplied by the number for the total consuming population yields an estimate of the lower limit of the range of the exposed population.

Values for the percent of the U.S. population that consumes a specific food item are available for some food items from the U.S. Department of Agriculture (USDA) Food Consumption Surveys. USDA Food Consumption Surveys are conducted approximately every 10 years. The most recent survey was in 1977-78, but the complete data reports for the 1977-78 survey have not yet been released. Therefore, the investigator must use data collected in the 1965-66 survey. Food Consumption of Households in the U.S., Seasons and Year 1965-66 (USDA 1972) presents data on food consumption by households in the 48 conterminous states for the period from April 1965 to March 1966. The percent of 15,112 households using selected food items for a seven-day period prior to the interview is presented.

The food items for which data are available represent a wide range of major food groups. The households surveyed were scientifically selected to represent a self-weighting sample of housekeeping households in each of four census regions during each of the four seasons. Excluded from the survey were those households in which no member ate as many as 10 meals from the household food supply during the seven days preceding the interview. Food Consumption of Households in the United States, Seasons and Year 1977-78, the most updated version of the 1972 USDA report, is expected to become available in mid 1983. Food Consumption of Households in the U.S., Spring 1977 (USDA 1982) presents preliminary data on food consumption of households in the 48 conterminous states during the period from April to June of 1977. Like the 1965-66 survey, this one presents the percent of 15,000 households using food items for a period of seven days prior to the survey. Unlike the survey of 1965-66 (USDA 1972), the survey of 1977-78 (USDA 1982) included households regardless of the number of meals eaten away from home.

Information used to obtain values for the percent of a food item produced via a specific agricultural practice or in a specific geographic area is available for select food items from two data sources. The _1978 Census of Agriculture, U.S. Summary_ (Bureau of the Census 1982a) presents statistics for the leading states and counties for select agricultural products based on data obtained from the Census of Agriculture. More detailed information was obtained for farms with sales of $2,500 or more than for farms with less gross sales. Statistics on value of agricultural products sold, number of acres harvested, and quantity harvested are included.

Agricultural Statistics 1978 (USDA 1978) also presents data for production and value of select agricultural products and utilization (e.g., fresh, frozen, canned, dried) of quantities sold. Some statistics for states are included. If the quantity of a food item harvested from a specific geographic region is desired and is not included in either of these two sources, the information, if available, can be obtained by contacting the Statistical Reporting Service-Crop Reporting Board of the United States Department of Agriculture ((202) 447-4020).

The basic steps for enumerating populations exposed to chemical substances via the ingestion of food contaminated by some form of agricultural practice is presented in Method 4-2. The approach can be used for virtually any situation.

4.3.2 Enumeration of the Populations Exposed as a Result of Processing and Packaging

The procedures for enumerating the population exposed to a chemical substance as a result of consuming a food contaminated during processing and packaging are similar to the procedure discussed in Section 4.3.1. If a food is contaminated during a processing procedure (e.g., canning, freezing, drying), the investigator must determine the percent of the U.S. population that consumes the processed food item. This percentage is multiplied by the total 1980 U.S. population to determine the consuming population. If the chemical substance contaminating the processed food is generic to all methods for producing the processed food item, then the exposed population is equal to the consuming population. If, however, the chemical substance is specific to only certain methods, then the consuming population is the upper limit of the range of the exposed population. To determine the lower limit of the range of the exposed population, the investigator must determine the fraction of the food that undergoes the specific processing method; this fraction is multiplied by the consuming populations.

Method 4-2. Enumeration of Populations Exposed as a Result of Agricultural Practices

Step 1 Determine the percentage of households that consume a specific food item by consulting *Food Consumption of Households in the U.S., Spring 1977 (USDA 1982)*. Statistical evaluation of seasonal data by USDA (1972) indicates that household food consumption at home in the spring is more representative of average consumption during the year than is consumption in the summer, fall, or winter. *Food Consumption of Households in the U.S., Seasons and Year 1977-78*, the best information source, will be published in mid 1983.

Step 2 Multiply the percentage determined in Step 1 by the total U.S. resident population in 1980 of 226,500,000 (Bureau of the Census 1982b) to calculate the consuming population or the upper range of the exposed population.

Step 3 Define the contaminated area by county, and determine the percentage of the total quantity of the food item harvested from the geographic area subjected to the agricultural practice by consulting the *1978 Census of Agriculture* (Bureau of the Census 1982a) and *Agricultural Statistics* (USDA 1978). If the information needed is not in this report, contact the USDA, Statistical Reporting Service - Crop Reporting Board ((202) 449-4020).

Step 4 Multiply the fraction derived in Step 3 by the value calculated for the consuming population in Step 2. The resulting value is the estimated lower limit of the exposed population.

The technique for enumerating the population exposed to a chemical substance in food as a result of packaging is the same as that discussed for exposure from processing. The consuming population (i.e., the upper limit of the exposed population) is estimated first. The investigator determines what fraction of the food undergoes a specific packaging procedure and then multiplies that fraction by the population estimated to consume the food item to estimate the lower limit of the range. The following paragraphs discuss the sources of information for the data needed to perform these calculations.

The report Food Consumption of Households in the United States, Spring 1977-78 (USDA 1982) should be used to obtain values for the percentage of the U.S. population that consumes select food items. This data source has been discussed in detail in the previous subsection. This report also includes data on processed food consumption for select food items (e.g., canned peas, frozen peas, powdered milk).

There is no comprehensive source of data reporting the percentage of specific methods and chemicals for processing or packaging materials for specific foods and beverages (e.g., the percentage of meats processed with or without nitrites; the percent of frozen broccoli packaged in cardboard vs. that packaged in plastic film). This information may be available from the trade association corresponding most closely to the food item or packaging procedure in question. For a comprehensive listing of trade associations, consult the most recent issue of the "Encyclopedia of Associations" published by Gale Research, Inc. The procedural steps to enumerate populations exposed to a chemical substance via the ingestion of food contaminated by processing and packaging are presented in Method 4-3.

In some instances, the contamination from processing or packaging of a specific food item may result from procedures used by a specific company. The number of people that consume a specific brand of food or beverage can be estimated for select foods and beverages from the Simmons Media Studies Volumes on Food and Food Marketing, Alcoholic Beverages, and Carbonated Soft Drinks and Pet Food (SMRB 1977). EPA-OTS is in the process of acquiring the latest Simmons Market Research Bureau (SMRB) reports. Volumes for 1976-77 are available in the Washington, D.C. area at the George Mason University Library.

The SMRB studies are designed to make it possible for advertisers and agencies to assess the relative values of media in terms of marketing potential for over 500 product and service categories and 3,000 individual brands. The studies present demographic and lifestyle characteristics, media habits, and product use, based on data collected from one of the largest annual national consumer probability samples taken. Respondents are selected to represent the conterminous U.S. population 18 years of age and older. It should be noted that, for most food items listed, the number of users is based on the total U.S.

Method 4-3. Enumeration of Populations Exposed as a Result of Packaging and Processing of Food

Step 1 Determine the percentage of users of the food from Food Consumption of Households in the U.S. Spring 1977 (USDA 1982). This report contains values for both processed and unprocessed foods.

Step 2 Multiply the percentage (i.e., fraction) obtained in Step 1 by the U.S. population in 1980 of 226,500,000 (Bureau of the Census 1982b) to estimate the consuming population. This is the upper limit of the exposed population. If the chemical substance is generic to all methods for producing the processed food, then the exposed population is equal to the total consuming population.

Step 3 If a chemical substance is introduced to a food item (1) via a specific method for processing or (2) from a packaging procedure or material, investigators must determine what portion of total production for that food item is affected. These data may be difficult to obtain. Food Consumption on Households in the U.S. Spring 1977 (USDA 1977) provides data on the percentage of users of food items prepared by such processes as canning, drying, and freezing. Trade associations that are related to the food item may have this information. Processing and packaging associations (e.g., National Food Processors Association, Washington, D.C.) may also have this information. For a comprehensive listing of trade associations, consult the most recent issue of the "Encyclopedia of Associations" published by Gale Research Corp.

Step 4 Multiply the total consuming population estimated in Step 2 by the percentage determined in Step 3 to estimate the lower limit of the range of the exposed population. If no information on the percentage of the food item packaged or processed by the method causing contamination is obtained in Step 3, the upper limit estimated in Step 2 should be used; however, it should be clearly labeled as a possible overestimate.

population of female homemakers (the buyers of the food) and not the total U.S. population 18 years of age and older. The data, however, can be used to approximate household use. Section 5 of this volume, Populations Exposed to Chemical Substances via the Use of Consumer Products, provides greater detail on the use of SMRB data.

To enumerate the population exposed as a result of consuming food contaminated by processing or packaging procedures used by a specific company, the general approach described in Method 4-4 should be used. In some cases, data will be reported only for the female homemaker. To extrapolate for the total consuming population, investigators should (1) refer to SMRB data (which provide the number of persons in the buyer's household) or (2) use a generic multiplication factor of 2.73 persons per household (Bureau of the Census 1982c).

4.3.3 Enumeration of Populations Exposed as a Result of Releases from Other Sources

This category includes all forms of food contamination that are not the result of either an agricultural practice or a processing and packaging procedure. This section concentrates principally, however, on chemical substances introduced as a result of accidents (e.g., introduction of PBB to cattle feed in Michigan) and from point source airborne or waterborne effluents (fish contaminated from industrial discharges, airborne particulates deposited on fruits and vegetables). The source of the chemical substance need not be identified. The methods in this section also apply to foods from geographically defined areas of contamination which have been identified from monitoring data. This special case is discussed in Subsection 4.3.4.

The procedure for enumerating the population exposed to a chemical substance as the result of consuming a food item contaminated from such sources is similar to the procedures previously discussed. The investigator must first determine the percent of the U.S. population that consumes the food item. This percentage is applied to the total 1980 U.S. population to determine the total consuming population. Next, the percent of the total quantity of the food item in the U.S. from the geographic area affected by the source of contamination must be ascertained. The product of the total consuming population and the percent of the food item affected by the source provides an estimate of the lower limit of the exposed population.

Four basic food groups may be affected by these sources of contamination: agricultural products, freshwater fish and game, seafood, and home grown foods. The method used to enumerate the exposed population is different for each of these basic food groups.

(1) Agricultural products. To enumerate the U.S. population exposed to a chemical substance as a result of consuming a contaminated agricultural product, the investigator should use the method for enumerating the population exposed as a result of agricultural practices

Method 4-4. Enumeration of Populations Exposed as a Result of Packaging or Processing Procedures Used by a Specific Company

Step 1 Identify the affected brand of food, and obtain use data from the Simmons Market Research Bureau reports (SMRB 1977). Users may be reported as total adults or female homemakers.

Step 2 Estimate the total consuming population for the food brand.

Option 1 - The average number of persons per household is 2.73. Assuming that there is one food shopper per household, multiply the total number of buyers by 2.73 to calculate the exposed population.

Option 2 - Simmons data are aggregated by the number of persons in a user's household. (This is fully discussed in Section 5.3.1 of this report.) The calculation is performed as follows:

1 person household = number of buyers x 1 = A
2 person household = number of buyers x 2 = B
3-4 person household = number of buyers x 4 = C
5 or more person household = number of buyers x 6 = D

A + B + C + D = total exposed population (estimated conservatively).

(see Method 4-2, described in Section 4.3.1). Instead of determining the percent of the total quantity of the food item harvested from the geographic area subjected to the agricultural practice (Step 3), determine the percent of the food from the geographic area that has been contaminated.

(2) Noncommercial fish and game. To enumerate the U.S. population exposed to a chemical substance as a result of consuming contaminated freshwater fish or game, the investigator can use information from the fish and game commission of the state in which the contaminated area is located. The sample population for these surveys comprises hunters and fishermen who have purchased licenses from the state conducting the surveys. Based on information from the few states contacted, most states conduct surveys of this nature about every five years. An example of the type of survey information that may be pertinent is the summary of applicable categories of results included in the 1975 Fishing Survey conducted by the State of West Virginia (West Virginia DNR 1979). These categories include:

1. Estimated number of fishermen and days fished by type of fishing.

2. Estimated number of fishermen and days fished by district (WVA DNR) fished and type of fishing.

3. Estimated number of fishermen and days fished by river system and major river.

4. Estimated number of fishermen and days fished in lakes and impoundments.

To enumerate the population exposed to a chemical substance as a result of consuming noncommercial freshwater fish or game contaminated, from an identified source, the investigator should use Method 4-5. The estimated exposed population obtained in Step 1 of this method underestimates the actual exposed population because it represents the number of licensed hunters or fishermen in a defined geographic area and does not include all the consumers of the fish or game (such as friends and family members). If it is assumed that each license represents a household, the exposed population can be estimated, as presented in Step 2, by multiplying the number of licenses by 2.73, the average number of persons per household (Bureau of the Census 1982c).

(3) Commercial fish and shellfish. To enumerate the population exposed as a result of consuming seafood contaminated by releases from an identified source, one must determine the percent of the U.S. population that consumes the food item. The percent of the total quantity of the food item from the geographic area affected by the source of contamination must also be ascertained.

Method 4-5. Enumeration of Populations Exposed as a Result of Consuming Noncommercial Freshwater Fish or Game from a Geographically Defined Area of Contamination

Step 1	Obtain the number of licensed fishermen or hunters reported to fish or hunt in the geographically-defined area of contamination by contacting the state fish or game commission. The best source of this information is usually the most recent fish and game survey conducted by the state fish and game commission.
Step 2	Estimate the upper limit of the actual exposed population by assuming that each licensed fisherman or hunter represents a consuming household. Since there are 2.73 persons in the average household (Bureau of the Census 1982c), a rough estimate of the actual exposed population can be calculated by multiplying 2.73 by the number of licensed hunters or fishermen obtained from Step 1.

Values for the percent and projected number of individuals in 1980 who consume the 45 most commonly eaten species of seafood are available in the Report to the National Marine Fisheries Service on Seafood Consumption Patterns by NPD Research Inc. (NPD 1977). Table 16 summarizes the statistics on seafood consumption compiled by NPD (1977).

The quantity of the food item from the geographic area affected by the source of contamination can be obtained from a computerized data base maintained by the National Oceanic and Atmospheric Administration (NOAA) for all states except Maryland. The NOAA data base includes catch records by NOAA area or by county for oysters, finfish, and crabs. Catch records for clams are available only for descriptive areas such as "Mouth of the Patuxent River." Catch records for clams, oysters, and finfish are available in the form of daily records for the years 1975 through 1981. Catch records for crabs are available only for 1981. For information on retrieving data from the NOAA computerized data base, contact Daryl Christensen of the National Marine Fisheries Service at (201) 872-0200. For retrieval of data on seafood catches for the Chesapeake Bay, contact Mike Burch of the Statistics Division of the Maryland Department of Natural Resources at (301) 269-3784. There is no charge to government agencies for either of these services.

For information on the total quantity of seafood species caught in the United States, the statistics on commercial fishery landings published in Fisheries of the United States, 1980 by the National Marine Fisheries Service of NOAA (NOAA 1981) can be used.

The general approach for enumerating the population exposed to a chemical substance as a result of consuming seafood contaminated by releases from an identified source is presented in Method 4-6.

Table 16 includes a few freshwater fish species. Method 4-6, however, cannot be used to enumerate the population exposed as a result of consuming these fish species. To obtain such information, investigators must ascertain the quantity of freshwater fish caught annually from the geographically defined area of contamination. Although the quantity of select seafood items caught from a geographically defined area of contamination can be obtained from computerized NOAA data, no similar data base for freshwater fish was found.

(4) Home grown fruits and vegetables. In 1977, it was estimated that 44 percent of U.S. households (32 million households) had home gardens (USEPA 1980). Furthermore, 80 percent of these 32 million households had gardens every year, and 40 percent of these 32 million households had had gardens for 11 years or more. The consumption of home grown foods, therefore, may be a significant route of exposure, both short- and long-term, if the garden is located near a point source of contamination, such as a smelter.

Table 16. Ranking of Seafood Species by Percent of Individuals Consuming and Projected 1980 Consuming Population

Rank	Species	Number of users	Percent of sample size	Projected number of total 1980 population (X 1,000)
	Total sample	25,947	100.0	226,000
	Total seafood	25,165	94.0	204,000
1	Tuna, light	16,817	64.8	146,000
2	Shrimp	5,808	22.4	50,600
3	Flounders	3,327	12.8	28,900
4	Ocean Perch	2,519	9.7	21,900
5	Salmon	2,454	9.5	21,500
6	Clams	2,242	8.6	19,400
7	Cod	1,492	5.6	12,700
8	Pollock	1,466	5.6	12,700
9	Haddock	1,441	5.6	12,700
10	Herring	1,251	4.8	10,800
11	Oysters	1,239	4.8	10,800
12	Crab, other than King	1,168	4.5	10,200
13	Trout (Freshwater)	970	3.7	8,360
14	Catfish (Freshwater)	876	3.4	7,680
15	Bass	826	3.2	7,230
16	Lobster, Northern	675	2.6	5,880
17	Mackeral, Other than Jack	616	2.4	5,420
18	Halibut	574	2.2	4,970
19	Scallops	526	2.0	4,520
20	Whitefish	492	1.9	4,290
21	Snapper	490	1.9	4,290
22	Hake	392	1.5	3,390
23	Pike	390	1.5	3,390
24	Lobster, Spiny	350	1.3	2,940
25	Smelt	328	1.3	2,940
26	Perch (Freshwater)	268	1.0	2,260
27	Bluegills	265	1.0	2,260
28	Bluefish	236	0.9	2,030
29	Crappie	228	0.9	2,030
30	Trout (Marine)	220	0.8	1,810
31	Bonito	148	0.6	1,360
32	Crab, King	130	0.5	1,130
33	Mullet	97	0.4	904

Table 16. (Continued)

Rank	Species	Number of users	Percent of sample size	Projected number of total 1980 population (X 1,000)
34	Spot	91	0.4	904
35	Croaker	76	0.3	678
36	Anchovies	75	0.3	678
37	Rockfish	75	0.3	678
38	Catfish (Marine)	70	0.3	678
39	Groupers	68	0.3	678
40	Carp	64	0.2	452
41	Buffalofish	60	0.2	452
42	Sunfish	60	0.2	452
43	Drums	58	0.2	452
44	Scup	55	0.2	452
45	Other Shellfish	54	0.2	452
46	Abalone	48	0.2	452
47	Squid and Octopi	45	0.2	452
48	Swordfish	41	0.2	452
49	Butterfish	39	0.2	452
50	Shad	39	0.2	452
51	Dolphin	34	0.1	226
52	Tuna, white	22	0.1	226
53	Mackeral, Jack	13	0.1	226
54	Snook	13	0.1	226
55	Tilefish	11	0.1	226
56	Blue Crab	11	0.1	226
57	Pompano	10	0.1	226
58	Kingfish	8	0.1	226
59	Sablefish	7	0.1	226
60	Sharks	3	0.1	226

Source: NPD 1977, NOAA 1978.

Method 4-6. Enumeration of Populations Exposed as a Result of Consuming Seafood from a Geographically Defined Area of Contamination

Step 1 Determine the number of users of the seafood by consulting the information in Table 15 on projected number of individuals in 1980 who consumed the seafood item of concern.

Step 2 Determine the percentage of the total quantity of the item caught for sale in the U.S. which is from the geographically defined area of the source of contamination. This can be accomplished by computing the quantity of the seafood caught annually from the geographically defined area of contamination based on computerized NOAA data. Next, the total quantity of the seafood species caught in the United States annually must be obtained from commercial fishery landings published in Fisheries of the United States, 1980 (NOAA 1981). The fraction of the total quantity of the seafood species caught for sale in the U.S. which is from the geographically defined area of the source of contamination can be computed by the following formula:

$$\frac{\text{quantity of the seafood item caught from the geographically defined area of contamination}}{\text{total quantity of the seafood item caught in the United States}}$$

Step 3 Multiply the fraction computed in Step 2 by the value determined for the consuming population determined in Step 1.

Table 17 presents data for the year 1977 on the percent of urban, rural non-farm, and rural farm households with gardens as well as the percent of the U.S. population for each category. These geographic categories are consistent with the census geography of the Bureau of the Census. Table 18 presents data on the percentage of total households growing, freezing, canning, or preserving selected home grown fruits and vegetables. The data presented in these two tables can be used to enumerate local populations exposed to a chemical substance via the consumption of inadvertently contaminated home grown fruits and vegetables. Method 4-7 presents that procedure.

4.3.4 Enumeration of Exposed Populations by the Use of Monitoring Data

The source of contamination of a food item will frequently be unknown. The fact that contamination exists, however, can be positively confirmed through monitoring data collected. Market Basket Surveys such as those conducted by the Food and Drug Administration (DHEW 1975) exemplify how food contamination can be detected. The consumers of the food item in which the substance has been detected are the exposed population.

Monitoring data can be used to predict the number of people consuming foods containing a chemical substance. The method extrapolates data on the frequency of detection of the substance. The accuracy achieved by this tool depends on the form, representativeness, and sample size of the data. The procedure for enumerating population by use of monitoring data is presented in Method 4-8.

The assumptions inherent in this very gross estimation include the assumption that the data are independent of the source of the contamination or that the data represent the total food supply from all geographic areas. Obviously, these assumptions limit the usefulness of the method; it should only be used in the absence of more refined data.

The use of monitoring data to estimate the exposed population is limited in all cases by two assumptions. The sample size must be large enough that the frequency of detection approximates the frequency of occurrence, and individuals who consume food containing the chemical at levels below the detection limit are not included in the exposed population. Exposure below the detection limit may, however, be significant for certain chemicals.

Table 17. Percent of Households, U.S. Population, and Household Size in Urban, Rural Non-Farm, and Rural Farm Areas with Home Fruit and Vegetable Garden in 1977

Urbanization	Percent households with garden	Household size (number of persons)	Percent of total U.S. population
Urban	43	3.17	32
Rural non-farm	41	3.44	9
Rural farm	84	3.86	3

Source: USEPA (1980).

Table 18. Percent Gardening Households Growing, Freezing, Canning, or Preserving Selected Home Grown Fruits and Vegetables, 1975-77

Item	Grown			Frozen			Canned or Preserved		
	1975	1976	1977	1975	1976	1977	1975	1976	1977
Vegetables									
Tomatoes	95	97	91	26	29	26	65	66	58
Beans (green, wax, lima, etc.)	71	69	70	54	49	55	42	35	38
Cucumbers	62	61	59	4	*	2	29	23	29
Peppers	61	60	60	28	28	32	10	11	7
Radishes	59	54	50	*	*	*	*	*	*
Green onions (scallions)	58	54	50	2	*	4	1	*	*
Lettuce	56	55	51	1	*	*	*	*	*
Onions	52	54	48	3	*	*	4	*	*
Carrots	50	46	46	15	12	16	8	9	8
Corn	50	44	49	41	36	39	15	9	11
Squash	45	41	41	21	19	22	8	4	3
Beets	40	42	38	7	7	9	29	29	24
Peas	40	36	38	27	26	31	7	4	7
Turnips	26	25	22	7	6	4	1	1	2
Potatoes	10	37	39	*	*	*	*	*	3
Cabbage	7	37	40	*	*	10	*	2	8
Fruits									
Strawberries	22	21	22	16	13	14	9	4	3
Apples	20	17	20	11	8	13	15	7	10
Melons	13	15	17	3	*	*	1	*	*
Peaches	13	10	12	7	5	7	10	5	7
Pears	10	7	8	3	*	*	10	*	1
Rasberries, blackberries, blueberries, etc.	6	10	16	5	7	12	3	4	5

*Either not mentioned or mentioned by less than 1 percent of the gardening households surveyed.

Source: USEPA (1980).

Method 4-7. Enumeration of Populations Exposed to Chemical Substances via the Consumption of Home Grown Fruits and Vegetables

Step 1 Identify the geographic area contaminated from the source of the chemical substance (e.g., industrial point source, area source).

Step 2 Determine the number of households in the geographic area from *General Population Characteristics*, Series PC80-1-B (Bureau of the Census 1982b).

Step 3 Multiply the number of households obtained in Step 2 by the percent of households with home fruit and vegetable gardens for the type of urbanization from Table 16. This is the number of households with fruit and vegetable gardens in the area contaminated, the inhabitants of which are the potentially exposed population.

Step 4 Enumerate the exposed population by multiplying the number of households from Step 3 by the household size for the degree of urbanization also available in Table 16.

Step 5 Steps 3 and 4 determined the number of households and individuals that have fruit and vegetable gardens, not the households that grow a specific type of food. If the chemical substance is absorbed by a specific food item, the data in Table 17 can be used. For example, if a pollutant is absorbed specifically by lettuce, the number of households for each population category estimated in Step 3 must be multiplied by 51 percent, the percentage of gardening households that grow lettuce according to the latest available data. These results should then be multiplied by household size (Table 16) to enumerate the exposed population.

Method 4-8. Enumeration of Exposed Populations by the Use of Monitoring Data

Step 1	Identify the food items contaminated as a result of the monitoring survey results.
Step 2	Enumerate the total consuming population for each of the food items identified. The enumeration procedures of Methods 4-2, 4-5, 4-6, or 4-7 should be used to estimate the consuming population. This is the upper limit of the range of the exposed population (i.e., all consumers of the food item eat some contaminated food).
Step 3	Calculate the frequency of detection from the monitoring data; if detected in 10 of 100 samples, the detection frequency is 10 percent.
Step 4	Multiply the detection frequency by the total consuming population as enumerated in Step 2 to estimate the exposed population. This is the lower limit of the range of the exposed population (i.e., the exposed population consumed only contaminated food).

4.4 Characterization of the Exposed Population

This subsection describes the data sources and procedures for characterizing the exposed population with respect to age and sex. In most exposure assessments, age and sex characterization will not be necessary. If, however, the chemical substance of interest has special effects on particular age classes such as children or the elderly, further characterization of the enumerated population is indicated. If a chemical substance is determined to be teratogenic, enumeration of women of child bearing age may be required. Age and sex also influence the average rate of food intake and the types of food consumed. Construction of a plausible worst-case exposure scenario for contaminated food may, for instance, focus on males 19 to 22 years of age; they have the highest average daily food intake rate (USDA 1980).

The simplest and most rapid method of characterizing a large population is to assume that the age and sex distributions approach those of the total U.S. population. This approach can be used only for very large, generally-defined populations. For example, the population consuming the typical "American Diet" or those who consume groups of major food categories approximate the national distribution. The age and sex distribution by percentage of the total U.S. population has been presented in Table 12 of Section 2.4 of this report (Characterization of Populations Exposed to Chemical Substances in the Ambient Environment). The characterization of populations exposed to chemical substances through the consumption of particular food items, however, often requires a much more accurate approach; the defined food preferences vary greatly according to particular age and sex, and even by sex within age classes.

There are two data sources for characterizing populations exposed to chemical substances via food consumption: USDA's food consumption surveys for individuals and the Simmons Market Research Bureau reports. The USDA data are applicable to populations eating various types of food, while SMRB marketing information is useful for characterizing consumers of specific brands of foods.

The individual food consumption surveys conducted by USDA were designed to be representative of the U.S. population. As a result, the age and sex distribution of the sampled population closely approximates that of the U.S. as a whole. Data on usage are reported for various age and sex groups, as illustrated in Figure 18, as percentages of the total sample within that group. Percents reported under the column heading for the food of interest can be applied directly to the total U.S. population for that age/sex classification to characterize the exposed population. Method 4-9 presents the steps to be performed for this type of characterization.

TABLE 1.2b.--MILK, MILK PRODUCTS; EGGS; LEGUMES, NUTS, SEEDS
Individuals using[1] in a day,[2] spring 1977
48 States, all urbanizations, all incomes

Sex and age (years)	Individuals	Milk, milk products						Eggs	Legumes, nuts, seeds
		Total	Milk, milk drinks			Cream, milk desserts	Cheese		
			Total	Fluid milk	Yogurt				
	Number	Percent							
Males and females:									
Under 1........	[3]78	92.2	92.2	60.9	0	6.5	3.6	10.0	14.5
1-2............	[4]264	93.4	90.9	90.5	.6	19.3	21.7	33.3	22.8
3-5............	437	91.7	87.8	85.6	.3	21.8	21.0	33.6	30.7
6-8............	469	93.4	90.5	88.5	1.2	25.0	19.7	24.3	29.4
Males:									
9-11...........	216	92.9	90.7	87.9	.5	24.3	16.1	26.4	28.0
12-14...........	313	90.2	86.3	81.1	.4	23.0	14.5	28.8	27.5
15-18...........	400	85.9	77.3	75.7	.7	27.9	20.7	30.4	20.9
19-22...........	287	81.6	74.3	69.7	1.3	16.4	26.0	30.1	17.7
23-34...........	770	73.8	58.3	53.6	2.9	21.9	28.3	33.7	19.7
35-50...........	784	75.8	57.6	56.5	.8	24.1	27.0	39.8	22.5
51-64...........	634	77.8	61.8	60.9	1.1	26.2	25.9	40.1	20.5
65-74...........	295	81.3	71.2	70.4	.3	29.1	24.8	47.7	15.2
75 and over.....	127	80.7	67.9	66.3	0	25.8	25.2	51.5	20.3
Females:									
9-11...........	241	92.5	88.8	86.8	0	25.6	16.8	19.7	30.6
12-14...........	309	88.6	80.9	76.2	.3	22.7	22.8	23.4	21.0
15-18...........	402	85.4	74.7	69.2	2.0	24.2	24.9	25.5	18.0
19-22...........	337	78.1	65.1	62.3	1.9	18.3	26.9	27.2	14.3
23-34...........	949	74.3	58.6	54.5	3.4	18.8	28.5	31.3	18.2
35-50...........	942	73.0	55.2	52.6	2.8	21.4	28.0	28.0	17.4
51-64...........	792	73.9	58.2	56.0	2.5	21.1	26.8	33.2	17.1
65-74...........	377	80.3	68.4	67.3	2.7	26.9	25.6	32.9	11.7
75 and over.....	197	84.2	73.1	71.4	2.0	28.4	24.5	32.2	9.6
All individuals...	[5]9,620	80.7	68.8	65.9	1.7	22.8	24.7	31.9	20.2

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[1] User is an individual reporting a specified food item.
[2] Based on 24-hour dietary recall of day preceding interview.
[3] Excludes 36 breast-fed infants.
[4] Excludes 4 breast-fed infants.
[5] Excludes 40 breast-fed infants.

Source: USDA (1980).

Figure 18. Example Data Summary from National Food Consumption Survey of 1977-78

Method 4-9. Characterization of Populations Exposed to Chemical Substances in Types of Food

Step 1 Locate the food item usage data in the USDA (1972, 1980) food consumption surveys for individuals in one day. The more recent (1980) data should be used whenever possible.

Step 2 Apply the "percent using" value for each age/sex category to the corresponding total population in that category (from Table 13).

Step 3 Compare "percent using" for the total sample as reported in the one-day survey to the "percent using" reported in the USDA (1982) one-week household consumption survey. This comparison will provide a qualitative indicator of the one-day survey's accuracy. If the data values are significantly different (i.e., the individual consumption data in USDA (1972, 1980) underestimates the consuming population), the total consuming population should be estimated using household data (USDA 1982) as presented in Step 1 of Method 4-2. The percentage of the total consuming population that is in the age or sex group of interest should be determined from the individual survey data (USDA 1972, 1980). This is calculated by aggregating the consumers for each age or sex class and dividing by the total consuming population of the individual sample. This percentage should then be applied to the total consuming population determined from the household data to characterize the exposed population (See Appendix A-3, problem 7).

Though the sample population is representative of the age and sex distribution of the U.S. population, a limitation inherent in the one-day survey biases the data. Consumption during one day may not be representative of normal eating patterns; this generally results in an underestimate of the number of consumers of specific foods. The one-day survey is, however, the only source of consumption data that presents the information by age and sex. Method 4-9 provides an approach to determine the accuracy of the individual consumption data and a procedure that can be used to eliminate the error.

Age and sex distributions of populations that consume specific brand names of food can be derived from the Simmons Market Research Bureau Reports. The most recent version of this report is available in EPA-OTS. Reports for the years 1977 through 1978 are available in the Washington, D.C., area at the George Mason University Library. SMRB reports present demographic data for most major brand name food items.

Section 5 of this report discusses the use of SMRB data to characterize populations using consumer items; that discussion is equally relevant to food consumption. In essence, SMRB presents information on the frequency that sample households include children within certain age groups. The ages of the adults in the household are similarly reported as frequencies. A general age distribution can thus be compiled easily for any item; the proportion of males and females can be assumed.

4.5 References

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5. POPULATIONS EXPOSED TO CHEMICAL SUBSTANCES VIA THE USE OF CONSUMER PRODUCTS

5.1 Introduction

This section presents methods for enumerating and characterizing populations exposed to chemical substances via the use of consumer products. The methods described are applicable to new and existing substances in consumer products. Figure 19 is a flow diagram of the three-stage method framework. Included in the diagram are some of the major data sources used.

The identification of the exposed population is discussed only briefly in this report (Subsection 5.2). The process is straightforward and relies primarily on materials balance information and data generated by the consumer exposure assessment methods report (Volume 7).

Enumeration of exposed populations may involve one or more steps and a variety of data sources. Subsections within Section 5.3 describe the sources of data applicable to enumeration of consumers and methods for utilizing and refining available data.

The age and sex of the exposed consumers affect the physiological parameters (i.e., breathing rate, skin surface area) that determine exposure; they also identify sensitive subpopulations (e.g., women of child-bearing age). Detailed exposure assessments may require that populations be described by age and sex distribution. Subsection 5.4 discusses methods of characterizing exposed consumer populations.

Examples of the use of the methods in this section are presented in Appendix A-4 of this report.

5.2 Identification of Exposed Populations

The identification of populations exposed to chemical substances via the use of consumer products (Method 5-1) necessitates a listing of all products containing the chemical in question. The information needed to compile such a list is derived from the materials balance for existing chemicals, from information submitted by Premanufacturing Notice (PMN) petitioners, and through literature searches.

Exposure assessments for most existing chemicals include a materials balance delineating the uses for that chemical, as well as the amount going to each use. A PMN submittal provides the corresponding information for new chemicals. PMNs are, however, usually incomplete; use information is often general, and not all the potential uses of a new chemical will be considered. Volume 7 of this series (methods for assessing consumer exposure to chemical substances) presents methods to predict uses for new chemicals.

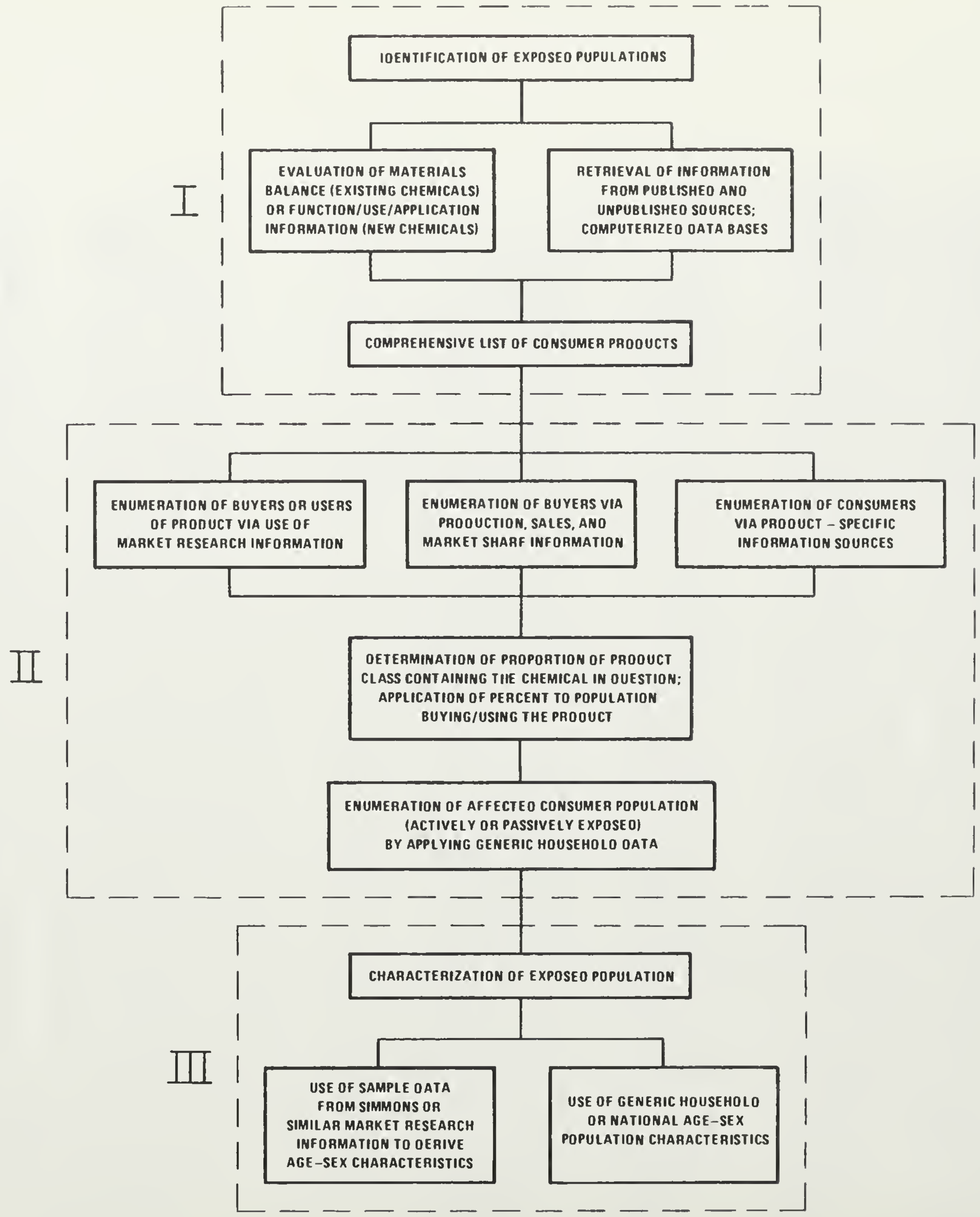
IDENTIFICATION OF EXPOSED POPULATIONS
I
EVALUATION OF MATERIALS BALANCE (EXISTING CHEMICALS) OR FUNCTION/USE/APPLICATION INFORMATION (NEW CHEMICALS)
RETRIEVAL OF INFORMATION FROM PUBLISHED AND UNPUBLISHED SOURCES; COMPUTERIZED DATA BASES
COMPREHENSIVE LIST OF CONSUMER PRODUCTS
II
ENUMERATION OF BUYERS OR USERS OF PRODUCT VIA USE OF MARKET RESEARCH INFORMATION
ENUMERATION OF BUYERS VIA PRODUCTION, SALES, AND MARKET SHARE INFORMATION
ENUMERATION OF CONSUMERS VIA PRODUCT – SPECIFIC INFORMATION SOURCES
DETERMINATION OF PROPORTION OF PRODUCT CLASS CONTAINING THE CHEMICAL IN QUESTION; APPLICATION OF PERCENT TO POPULATION BUYING/USING THE PRODUCT
ENUMERATION OF AFFECTED CONSUMER POPULATION (ACTIVELY OR PASSIVELY EXPOSED) BY APPLYING GENERIC HOUSEHOLD DATA
III
CHARACTERIZATION OF EXPOSED POPULATION
USE OF SAMPLE DATA FROM SIMMONS OR SIMILAR MARKET RESEARCH INFORMATION TO DERIVE AGE–SEX CHARACTERISTICS
USE OF GENERIC HOUSEHOLD OR NATIONAL AGE–SEX POPULATION CHARACTERISTICS

Figure 19. Three-stage Framework for the Identification, Enumeration and Characterization of Populations Exposed to Chemical Substances in Consumer Products

Method 5-1. General Procedure for Identifying Populations Exposed to Chemical Substances in Consumer Products

Step 1 Compile a comprehensive list of the consumer products known to or thought to contain the chemical substance by consulting the materials balance or PMN submittal.

Step 2 Determine whether all or a portion of the consumer product class contains the chemical; if possible, identify by brand name to expedite enumeration.

Step 3 Identify products obviously intended for use by males or females or specific age groups.

Step 4 Evaluate each product (using the guidelines in Volume 7 of this series) to determine whether passive exposure is of concern. Consumer product use patterns will identify the passively exposed population (i.e., family or household members).

Many types of consumer products are of varied formulation, and only a fraction of the product class (perhaps identifiable by brand name) may contain the chemical substance. This fact should be established during the population identification phase. For example, formaldehyde is used in some shampoos as a preservative; in order to define and enumerate the population exposed to formaldehyde in shampoo, one must determine what fraction or brands of the product class (shampoo) contain the chemical (formaldehyde). Methods for that purpose are presented in Subsection 5.3.

Some products may cause exposure not only to the user (active exposure) but also to others in the vicinity (passive exposure). Volume 7 presents some guidelines for identifying products that may cause passive exposure. Generally, passive exposure to consumers results from the use of household or personal care products; the passively exposed population is the household of which the user is a member. Subsequent sections address the concept of enumerating those passively exposed in households.

5.3 Methods for the Enumeration of Exposed Populations

The effort required to enumerate consumers exposed to a particular product depends on two factors: (1) the availability of data specific to that product and (2) whether both active and passive exposure to the substance are involved. The following subsections guide the assessor in obtaining the available data and present methods for their use.

5.3.1. Enumeration of Exposed Populations via Simmons Market Research Bureau Reports

Simmons Market Research Bureau (SMRB) is a market research corporation that collects information on the buying habits of the population through questionnaires administered to a nationwide panel of consumers. The Simmons studies, "Selective Markets and the Media Reaching Them" (SMRB 1982), are designed to serve retailers, advertising agencies, and the media by providing up-to-date, comprehensive information on current and potential sales markets of consumer products.

SMRB data applicable to enumerating exposed consumer populations are contained in 29 volumes organized by product category. Table 19 lists the 29 product categories. These volumes contain information on market share, the number of buyers, and buyer demographics for over 500 consumer products. Table 20 is an alphabetical index of individual products and services investigated by SMRB.

Table 19. Simmons Market Research Bureau Product Categories and Services Provided by Volume

Volume Number	Volume Title
P-1	Automobiles
P-2	Cycles, Trucks, Vans & Tires
	Automotive Products & Services
P-4	Travel
P-5	Banking Investments, Memberships & Public Activities
P-6	Insurance & Credit Cards
P-7	Books, Records, Tapes, Stereo & TV
P-8	Appliances, Sewing & Garden Care
P-9	Home Furnishings & Home Improvements
P-10	Sports & Leisure
P-11	Restaurants, Stores & Grocery Shopping
P-12	At Home Shopping, Yellow Pages, Florists & Telegrams
P-13	Jewelry, Wristwatches, Luggage & Men's Apparel
P-14	Women's Apparel
P-15	Tobacco Products & Photography
P-16	Distilled Spirits & Mixes
P-17	Malt Beverages & Wine
P-18	Coffee, Tea, Soft Drinks, Juices & Bottled Water
P-19	Dairy Products, Spreads, Cookies & Desserts
P-20	Cereals, Rice, Pasta, Pizza, Fruits & Vegetables
P-21	Soup, Meat, Fish, Condiments & Dressings
P-22	Chewing Gum, Candy & Snacks
P-23	Soap, Laundry & Paper Products & Kitchen Wraps
P-24	Household Cleaners, Room Deodorizers & Pet Foods
P-25	Health Care Products & Remedies
P-26	Oral Hygiene Products, Skin Care & Deodorants
P-27	Hair Care & Shaving Products
P-28	Women's Beauty Aids, Cosmetics & Personal Products
P-29	Games & Toys, Children's & Babies' Apparel & Specialty Products
P-30	Relative Volume of Consumption

Source: SMRB 1982.

Table 20. Alphabetical Index of Products and Services Measured in the 1982 SMRB Study

---

A

Aches, Muscle, Head or Back
Active Participation in Sports
Activities, Public
Adhesive Bandages
Adult Education Courses
After Shave Lotion & Cologne
Ailments
Air Conditioner, Room
Air Conditioning, Central
Air Filters
Air Freshener Sprays & Room Deodorizers
Airlines
Alarm, Burglar
Alarm, Smoke/Fire Detector
Ale
Allergies
Allergy & Cold Remedies
Aluminum Foil
American/Pasteurized Processed Cheese
Ammunition, Factory Loaded
Amplifier/Receiver/Tuner, Stereo
Annual Mileage Driven
Anti-Freeze
Anti-Perspirants & Deodorants
Aperitif & Specialty Wines
Apparel/Men's, Women's & Children's
Archery
Arthritis or Rheumatism
Asthma Relief Remedies
Athlete's Foot
Athlete's Foot Remedies
Attendance at Sports Events
Auto Insurance
Auto Loan
Automatic Dishwasher
Automatic Dishwashing Detergent
Automatic Drip Coffee Maker
Automatic Garage Door Opener
Automatic Washing Machine
Automobiles
Auto Racing or Rallying

B

Baby Foods
Baby Formula, Liquid
Baby Lotion & Baby Oil
Baby Nursers
Baby Oil & Baby Lotion
Baby Powder
Baby Shampoo
Backache
Backpacking/Camping Equipment
Backpacking or Hiking
Baggage or Luggage
Bags, Garbage & Trash Can Liners, Plastic
Bags, Sandwich or Food, Plastic
Baked Beans
Bandages, Adhesive
Banking & Investments
Barbecue & Seasoning Sauces, Bottled
Bath Oil & Other Bath Additives
Bathroom Cleaners (Household Cleaners)
Bathroom Plumbing Fixtures
Batteries, Car
Battery or Electric Shaver
Bedroom Furniture
Beds
Beer
Bench/Table Circular Saw
Bicycle
Bicycling
Biscuits or Treats, Dog
Blankets, Electric
Blankets, Other (Not Electric)
Blank Tape Cartridge, Cassette, Reel
Bleach
Blended or Rye Whiskey
Blender, Electric
Blouse/Shirt, Women's
Blusher
Boats
Boating
Body & Hand Cream, Lotion or Oil
Bonds
Bonnet-Type Hair Dryer
Book Clubs
Books
Boots, Hiking or Climbing
Boots, Leather
Boots, Ski
Bottled Natural Spring or Mineral Water
Bouillon Cubes & Dry Soup Mix
Bourbon Whiskey
Bowling
Bowling Ball
Bowling Shoes
Brake Lining Pads
Brandy & Cognac
Brassiere
Bread
Breakfast Cereals
Breakfast Drinks, Powdered Fruit Flavored
Breath Fresheners
Built in Automatic Dishwasher
Burglar Alarm
Bus Companies, Domestic
Business Club Membership
Business Purchase Decisions
Bus-Type Motor Home
Butter
Buying Style

C

Cabinets, Kitchen
Cables, Telegrams & Wires
Cake Mixes, Dry
Cakes, Pies & Pastries, Frozen
Calculator
Cameras
Camper, Tent (Folding)
Camper or Travel Trailer, Towable
Camper, Truck Mounted
Camping/Backpacking Equipment
Camping Trips, Overnight
Camping Vehicles
Canadian Whisky
Candy Bars & Packages, Regular Size
Candy, Fun, Miniature & Snack Size
Candygram
Candy, Hard Roll
Canned Cat Food
Canned Dog Food
Canned or Jarred Fruits
Canned Ham
Canned Macaroni & Spaghetti Products
Canned Soup
Canned Tea
Canned Tuna
Canned Vegetables, or Jarred
Canning Jars & Lids
Canoe
Canvas Shoes
Car Batteries
Car Leasing
Carpeting
Carpet Squares
Car Polish & Wax
Car Rental
Cars
Cartridges, Blank Tape
Cartridges, Pre-Recorded Tape
Casseroles & Entrees (Frozen Main Courses)
Cassette Deck
Cassette, Video Recorder/Player
Cassettes, Blank Tape
Cassettes, Pre-Recorded Tape
Casual/Leisure Suit
Cat Food
Cat Ownership
Catsup
CB Base Unit
CB Mobile Radio
Ceiling, Floor or Wall Insulation
Ceiling Tile, Residential
Central Air Conditioning
Cents-Off Coupons
Cereals
Certificates of Deposit/Savings Certificates
Chain Saw
Champagne, Cold Duck & Sparkling Wines
Check Guarantee Card
Checking Account
Checks, Travelers
Cheese
Chewing Gum
Chewing Tobacco
Children's Clothing
Children's Fever Reducers & Pain Relievers
Children's Shoes

Children's Vitamins
China, Fine
Chips, Corn & Tortilla, & Snacks
Chips, Potato
Christmas Club
Church Board Membership
Cigarette Rolling Paper
Cigarettes
Cigarillos & Little or Small Cigars
Cigars
Circular Saw
Citizens Band Base Unit
Citizens Band Mobile Radio
Civic Club Membership
Cleaners, Drain
Cleaners, Household (Including Bathroom/Kitchen)
Cleaners, Oven
Cleaners, Rug
Cleaners, Toilet Bowl
Cleaners, Window
Cleansing Creams & Lotions
Cleansing Wipes, Pre-Moistened, For Babies
Climbing or Hiking Boots
Cloth Coat, Women's
Cloth Diapers
Clothes Dryer
Clothing, Men's
Clothing, Women's
Clothing, Children's
Club, Book
Club, Civic
Club, Country
Club, Health
Club, Record & Tape
Club, Religious
Club, Tape
Club, Veterans
Coats, Men's
Coats, Women's
Cocktail Mixes, Prepared
Cocktail Parties
Coffee
Coffee Maker
Cognac & Brandy
Coin Collecting
Coins, Gold
Coins, Silver
Cola Drinks
Cold Cuts
Cold Duck, Champagne & Sparkling Wines
Cold & Allergy Remedies
Colds
College or School Board Membership
Cologne & After Shave Lotion
Cologne & Perfume
Coloring Products, Hair
Comb, Hair-Styling, Electric
Comforters/Quilts
Common Stock
Compact or Console Stereo
Compactor, Trash, Electric
Compact Pick-Up Truck
Complete Dinners, Frozen (TV Dinners)
Complete Packaged Prepared Dishes & Dinner Mixes
Computer, Home
Console or Compact Stereo
Constipation
Contact Lenses
Convection Oven
Convenience Stores & Supermarkets
Cooker, Pressure
Cookies (Ready-to-Eat)
Cooking for Fun
Cooking or Salad Oil
Cooking Spray, Non-Stick
Cookware Set, Metal
Cordials & Liqueurs
Corn & Tortilla Chips & Snacks
Costume Jewelry
Cottage Cheese
Cotton Swabs
Cough Drops
Coughs
Cough Syrup
Countries Visited—Foreign Travel
Country Club Membership
Coupons, Cents-Off
Courses For Adult Education
Crackers
Cream, Lotion or Oil, Hand & Body
Cream, Shave
Cream Substitutes, Non-Dairy
Credit Cards
Crystal Ware
Cross Country Snow Skiing
Cubes, Bouillon, & Dry Soup Mix
Cups, Disposable
Curler Set, Hair, Electric
Curtains/Draperies

D

Decaffeinated Instant or Freeze-Dried Coffee
Deck, Cassette
Deck, Eight Track (Record & Play)
Dental Insurance
Dentures
Deodorants & Anti-Perspirants
Deodorizers, Room, & Air Freshener Sprays
Department Stores & Discount Stores
Depilatories
Desk Top Calculator
Dessert Pies, Cakes & Pastries, Frozen
Desserts, Flavored Gelatin
Dessert Wines, Port & Sherry
Detector, Smoke/Fire
Detergent, Dishwashing
Detergents & Soaps, Laundry
Dial Face Wristwatch
Diamond Ring
Diapers
Diarrhea
Diesel Fuel & Gasoline
Diet Control
Diet or Low Calorie Carbonated Soft Drinks
Digital Face Wristwatch
Dining Room Furniture
Dinner Mixes, Complete Packaged, & Dishes
Dinner Parties
Dinners, Frozen Complete (TV Dinners)
Dinnerware
Discount Stores & Department Stores
Dishwasher, Automatic
Dishwasher Detergent, Automatic
Dishwashing Liquid
Disposable Cups
Disposable Diapers
Disposable Lighters
Disposable Razors
Disposal, Garbage
Dog Biscuits or Treats
Dog Food
Dog Ownership
Domestic Beer, Light/Low Calorie
Domestic Beer, Regular
Domestic Travel
Domestic Wine
Door Opener, Garage
Doors, Storm, or Windows
Door-to-Door Sales
Douches & Suppositories, Feminine Hygiene
Dough Products, Refrigerated
Downhill Snow Skiing
Draft Beer
Drain Cleaners
Draperies/Curtains
Drawing, Painting, Sculpting
Dresses or Suits, Children's
Dresses, Women's
Dressing, Salad
Dress or Regular Shirt, Men's
Drill, Electric
Drink Mixers, Prepared, Without Liquor
Drinks, Breakfast, Powdered Fruit-Flavored
Drinks, Fruit, & Juices
Drinks, Mixed, Prepared With Liquor
Drinks, Soft
Drinks, Soft, Powdered
Drip Coffee Maker, Automatic
Drive-In & Fast Food Restaurants
Driver's License
Driving
Driving, Type of Vehicle Driven
Dry Cake Mixes
Dry Cat Food
Dry Dog Food
Dryer, Clothes
Dryer, Hair
Dry Mix Salad Dressing
Dry Soup Mix & Bouillon Cubes
Dungarees or Jeans, Children's

E

Eczema
Education Courses for Adults
Eight Track Deck (Record & Play)
Electric & Battery Shaver
Electric Blankets
Electric Blender
Electric Chain Saw
Electric Circular Saw
Electric Clothes Dryer
Electric Coffee Maker
Electric Drill
Electric Food Processor
Electric Fry Pan
Electric Grill
Electric Hair Curler Set
Electric Hair Dryer
Electric Hair-Styling Comb
Electric Jig/Saber Saw
Electric Juicer

Electric Mixer
Electric Power Mower
Electric Range or Stove
Electric Refrigerator
Electric Sander
Electric or Battery Shaver
Electric Steam Cooker
Electric Toothbrush
Electric Trash Compacter
Electric Typewriter, Portable
Encyclopedia
Entrees & Casseroles (Frozen Main Courses)
Exterior House Paint & Stains
Eyeglasses
Eye Liner
Eye Shadow

F

Fabric Softeners
Face Powder
Facial Moisturizers & Cleansing Creams
Facial Tissues
Factory Loaded Ammunition
Family Restaurants & Steak Houses
Farm Ownership
Fast Food & Drive-In Restaurants
Feminine Hygiene Douches & Suppositories
Fertilizers
Fever
Fever Reducers, Children's, & Pain Relievers
Film
Film Processing
Filter or Purifier, Water
Filters, Air
Filters, Oil
Fire/Smoke Detector
Fishing
Fishing Reel
Fishing Rod
Fixtures, Lighting
Fixtures, Plumbing, Bathroom
Flatware
Flavored Gelatin Desserts
Flavored Snack, Saltine & Graham Crackers
Flea & Tick Care Products For Dogs & Cats
Floor, Ceiling or Wall Insulation
Flooring, Sheet Vinyl
Floor Polish & Wax
Floor Tile
Florists
Flowers by Wire
Flower & Vegetable Seeds
Fluorescent Lighting
Flying Private Plane
Foil, Aluminum
Folding Tent Camper, Towable
Food or Sandwich Bags, Plastic
Food Processor, Electric
Food Stores, Gourmet & Health
Foreign Travel
Formula, Liquid Baby
Foundation Makeup
Frankfurters & Wieners
Fraternal Order Membership
Freeze-Dried or Instant Coffee
Freezer, Home
Fresheners, Air & Room Deodorizers
Fresheners, Breath
Fresh Fruits
Fresh Water Fishing
Fresh Water Fishing Reel
Fresh Water Fishing Rod
Frozen Complete Dinners (TV Dinners)
Frozen Dessert Pies, Cakes & Pastries
Frozen Main Courses (Casseroles & Entrees)
Frozen Orange Juice
Frozen Pizzas
Frozen Potato Products
Frozen Vegetables
Frozen Yogurt
Fruit-Flavored Breakfast Drinks, Powdered
Fruit Juices & Drinks
Fruits, Canned or Jarred
Fruits, Fresh
Fry Pan, Electric
Fun, Miniature & Snack Size Candy Bars & Packages
Furnace
Furnishings, Household
Furniture
Furniture Polish

G

Games & Toys
Games, Video
Garage Door Opener, Automatic
Garbage Bags & Trash Can Liners, Plastic
Garbage Disposal
Gardening
Garden Tiller
Garden Tractor
Gas Chain Saw
Gas Clothes Dryer
Gas Grill
Gasoline & Diesel Fuel
Gasoline Additives
Gas Power Mower
Gas Range or Stove
Gelatin Desserts, Flavored
Gel or Cream, Shaving
Gems & Jewelry
Gifts by Wire
Gin
Girdle
Gloss, Lip & Lipstick
Gold/Gold Coins
Gold Jewelry
Golf
Golf Balls
Golf Clubs
Golf Courses
Golf Shoes
Gourmet Food Stores
Government, Local, Belong To
Grill, Electric
Grill, Gas
Grocery Shopping, Weekly Expenditure
Groin Irritation
Ground Coffee
Gum
Gun For Target Shooting

H

Hair Coloring Products
Hair Conditioners
Hair Curler Set, Electric
Hair Dryer
Hair Rinse, Creme
Hair Sprays
Hair-Styling Comb, Electric
Hair Tonic or Dressing
Ham, Canned
Hand Ball
Hand & Body Cream, Lotion or Oil
Hand-Held Hair Dryer, Electric
Hand-Held or Pocket Calculator, Electric
Hand Tool Outfit
Hard Cover Books
Hard Roll Candy
Hayfever
Headache Remedies & Pain Relievers
Headaches
Head Phones, Stereo
Health Club Membership
Health Food Stores
Health, Hospital or Medical Insurance
Heater/Stove, Wood Burning
Heater, Water
Heating, Solar
Heating Unit, Separate Room
Heat Pumps
Heavyweight Jacket
Hemorrhoids
Hiking or Backpacking
Hiking or Climbing Boots, Men's
Home Entertaining
Home Freezer
Home Improvements
Home, Mobile, Towable
Home, Motor, Bus-Type & Mini
Home Owners or Personal Property Insurance
Home, Vacation/Weekend
Horseback Riding
Hose or Stockings, Women's
Hospital Board Membership
Hospital, Medical or Health Insurance
Hotels & Motels
Hot Lather Machine
Hot Tub Systems
Hot Water Heater
Household Cleaners
Household Furnishings
House Paint
Humidifier, Room, Portable
Hunting
Hunting Rifle

I

Ice Cream, Ice Milk & Sherbert
Ice Tea Mix, Instant
Ice Skating
Illnesses
Imported Beer
Imported Dinner/Table Wines
Improvements, Home
Inboard/Outboard Power Boat
In-Bowl Toilet Bowl Cleaners
Indigestion Aids & Upset Stomach Remedies
Indigestion or Upset Stomach
Individual Retirement (IRA) or Keogh Plan
Indoor Gardening & Plants
Indoor Lighting Fixtures
Indoor-Outdoor Carpeting
Inflatable Boat

Insecticides
Instant Iced Tea Mix
Instant or Freeze-Dried Coffee
Instant Potatoes, Packaged
Instant Tea
Insulation for Ceiling, Floor or Wall
Insurance, Auto
Insurance, Dental
Insurance, Health, Hospital or Medical
Insurance, Home Owners or Personal Property
Insurance, Life
Insurance, Loss of Income
Insurance, Personal Liability
Insurance, Travel
Insurance, Vision Care
In-Tank Toilet Bowl Cleaners
Interior Wall Paint
Investment Property
Investments & Banking
Irish Whiskey

J

Jacket, Heavyweight
Jacket, Lightweight
Jacket, Sport
Jams & Jellies
Jarred or Canned Fruits
Jarred or Canned Vegetables
Jars, Canning & Lids
Jeans
Jellies & Jams
Jewelry, Costume
Jewelry & Gems
Jewelry, Gold
Jig/Sabre Saw
Jogging or Running
Jogging or Running Shoes
Juice, Orange, Frozen
Juice, Orange, In Bottles, Cans or Cartons
Juicer, Electric
Juices & Drinks, Fruit (Not Orange)
Juices, Tomato & Vegetable

K

Keogh Plan or Individual Retirement Plan (IRA)
Ketchup (Catsup)
Kitchen Cabinets
Kitchen Cleaners (Household Cleaners)
Kitchen Wrap, Plastic-Type
Knee High Hose

L

Lather Machine, Hot
Laundry Detergents & Soaps
Laundry Pre-Soaks & Pre-Cleaners
Laundry Washloads
Lawn Mower
Lawn/Porch Furniture
Lawn Seed
Laxatives
Leasing, Car
Leather Shoes
Leisure Activities
Leisure/Casual Suit
Lenses, Contact
Liability Insurance, Personal
Lids, Canning, & Jars
Life Insurance
Lighted Make-Up Mirror
Lighters, Disposable
Lighting Fixtures
Lighting, Fluorescent
Light/Low Calorie Domestic Beer
Lightweight Jacket, Men's
Lightweight Summer Suit
Liner, Eye
Liners, Trash Can, & Garbage Bags, Plastic
Lipstick & Lip Gloss
Liqueurs & Cordials
Liquid Baby Formula
Liquid Prepared Salad Dressing
Liquor, Malt
Living Room Furniture
Loan, Auto
Loan, Personal
Local Government, Belong To
Loss of Income Insurance
Lotion, After Shave & Cologne
Lotion & Oil, Baby
Lotion, Shave, Pre-Electric
Low Calorie or Diet Carbonated Soft Drinks
Lozenges, Throat, Medicated
Luggage or Baggage

M

Macaroni & Spaghetti Products, Canned
Mailgram
Mail Order
Main Courses, Frozen (Casseroles & Entrees)
Make-Up, Foundation
Make-Up Mirror, Lighted
Malt Liquor
Margarine
Mascara
Mattresses
Mayonnaise & Mayonnaise-Type Salad Dressing
Medical, Hospital or Health Insurance
Medicated Skin Care Products
Medicated Throat Lozenges
Membership, Business Club
Membership, Church Board
Membership, Civic Club
Membership, Country Club
Membership, Fraternal Order
Membership, Health Club
Membership, Hospital Board
Membership, Religious Club
Membership, Regional Development Committee
Membership, School or College Board
Membership, Union
Membership, Veterans Club
Menstrual or Period Pain
Metal Cookware Set
Microwave Oven
Mileage Driven in Last Year
Milk
Mineral & Spring Water, Bottled
Minibikes or Minicycles
Mirror, Make-Up, Lighted
Mixed Drinks, Prepared With Liquor
Mixer, Electric
Mixers, Drink, Prepared Without Liquor
Mixes, Cake, Dry
Mixes, Dinner, Complete Packaged, & Dishes
Mixes, Iced Tea, Instant
Mixes, Prepared Cocktail
Mixes, Salad Dressing, Dry
Mixes, Soup, Dry, & Bouillon Cubes
Mobile Home, Towable
Moist Cat Food
Moist Dog Food
Moisturizers & Cleansing Creams & Lotions, Facial
Money by Wire
Mopeds
Mortgage
Motels & Hotels
Motion Sickness
Motorcycles
Motorcycling
Motor Home, Bus-Type & Mini
Motor Oil
Motor Oil Additives
Motor, Outboard
Motorscooters
Mouthwash
Movie Cameras
Movie Projector
Movies, Attendance
Mower
Mufflers
Muscle Aches
Mustard
Mutual Funds

N

Nail Polish
Napkins & Pads, Sanitary
Nasal Sprays
Natural Cheese
Needlework
Nervous Tension
Non-Dairy Cream Substitutes
Non-Decaffeinated Instant or Freeze-Dried Coffee
Notions & Sewing Materials
Nursers, Baby

O

Oil Additives (Motor Oil Additives)
Oil & Lotion, Baby
Oil, Bath, & Other Bath Additives
Oil Filters
Oil, Motor
Oil, Salad or Cooking
Opener, Garage Door, Automatic
Orange Juice, Frozen
Orange Juice in Bottles, Cans or Cartons
Organ
Outboard/Inboard Power Boat
Outboard Motor
Outdoor Gardening
Outdoor-Indoor Carpeting
Outdoor Lighting Fixtures
Outerwear, Children's
Oven Cleaners
Oven, Microwave & Convection
Oven, Self/Continuous Cleaning
Overcoat-Topcoat
Ownership of Cats
Ownership of Dogs

P

Packaged Dry Cat Food
Packaged Dry Dog Food
Packaged Instant Potatoes
Packaged Moist Cat Food
Packaged Moist Dog Food
Packaged Prepared Dishes & Dinner Mixes, Complete
Paddle Ball
Pads, Scouring
Pain Relievers, Children's, & Fever Reducers
Pain Relievers & Headache Remedies
Pain Relieving Rubs & Liquids
Paint, Exterior House & Stains
Painting, Drawing, Sculpting
Paint, Interior Wall
Pancake & Table Syrup
Paneling, Wall
Pan, Fry, Electric
Pants Suit, Women's
Panty Hose
Paperback Books
Paper, Cigarette Rolling
Paper Cups, Disposable
Paper, Toilet
Paper Towels
Paper, Wall
Parties, Cocktail
Parties, Dinner
Parties, Other (Not Cocktail or Dinner)
Party/Pop/Sangria Wines
Passports
Pastries, Cakes & Pies, Frozen Dessert
Pasteurized Processed/American Cheese
Patterns, Sewing
Peanut Butter
Perfume & Cologne
Period or Menstrual Pain
Personal Liability Insurance
Personal Loan From Bank
Personal Loan From Finance Company
Personal Property or Home Owners Insurance
Pewter Flatware
Piano
Pick-Up Trucks
Pies, Cakes & Pastries, Frozen Dessert
Pillowcases
Pipe Tobacco
Pizzas, Frozen
Plants & Indoor Gardening
Plastic Garbage Bags & Trash Can Liners
Plastic Sandwich or Food Bags
Plastic-Type Kitchen Wrap
Platform Tennis
Player/Recorder, Video Cassette
Plumbing Fixtures, Bathroom
Pocket or Hand-Held Electronic Calculator
Poison Ivy, Oak or Sumac
Polish & Wax, Car
Polish & Wax, Floor
Polish, Furniture
Polish, Nail
Political Classification
Pool, Swimming
Porch/Lawn Furniture
Pork Sausages
Portable Circular Saw, Electric
Portable Dishwasher, Automatic
Portable Jig/Saw, Electric
Portable Room Humidifier
Portable Typewriter, Electric
Port, Sherry & Dessert Wines
Potato Chips
Potatoes, Frozen
Potatoes, Packaged Instant
Powder, Baby
Powdered Fruit Flavored Breakfast Drinks
Powdered Soft Drinks
Powder, Face
Powder, Scouring
Power Boat
Power Boating
Power Mower
Power Yard Trimmer
Pre-Cleaners & Pre-Soaks, Laundry
Preferred Stock
Pre-Moistened Cleansing Wipes for Babies
Pre-Soaks & Pre-Cleaners, Laundry
Prepared Cocktail Mixes Without Liquor
Prepared Dishes & Dinner Mixes, Complete Packaged
Prepared Mixed Drinks With Liquor
Prepared Salad Dressing, Liquid
Pre-Recorded Cassette Tape
Pre-Recorded Tape Cartridges
Pre-Recorded Tape Reel
Pressure Cooker
Pretzels
Processor, Food, Electric
Projector, Movie
Projector, Slide
Property, Investment
Property, Retirement
Psoriasis
Psychographics
Public Activities
Pumps, Heat
Purchase of Liquor or Wine By Case
Purifier or Filter, Water

Q

Quilts/Comforters

R

Racquet Ball
Racquet, Tennis
Radial/Arm Saw, Stationary
Radio, CB, Base Unit
Radio, CB, Mobile Unit
Radio Sports, Frequency of Listening
Raincoat or All Weather Coat
Range or Stove
Razor Blades
Razors, Disposable
Ready Made Draperies/Curtains
Real Estate
Receiver/Tuner/Amplifier, Stereo
Recliner
Recorder/Player, Video Cassette
Records
Record & Tape Clubs
Records & Tapes: Types Bought
Rectal or Vaginal Itching
Reel, Fishing
Reel, Tape, Blank
Reel, Tape, Pre-Recorded
Reel-To-Reel Tape Player/Recorder
Refrigerator
Regional Development Committee
Regular Candy Bars & Packages
Regular Carbonated Soft Drinks
Regular Domestic Beer
Regular or Dress Shirt, Men's
Regular Tea
Religious Club Membership
Remedies, Allergy & Cold
Remedies, Asthma
Remedies, Athlete's Foot
Remedies, Children's
Remedies, Headache & Pain Relievers
Remedies, Indigestion & Upset Stomach
Removers, Spot
Rental, Car
Residential Ceiling Tile
Restaurants, Family, & Steak Houses
Restaurants, Fast Food & Drive-In
Retirement Property
Rheumatism or Arthritis
Rice
Riding, Horseback
Rifle For Hunting
Ring, Diamond
Rinse, Hair, Creme
Roll Candy, Hard
Roller Skating
Rolling Paper, Cigarette
Roofing
Room Air Conditioners, Separate
Room Deodorizers & Air Freshener Sprays
Room Heating Unit, Separate
Room Humidifier, Portable
Rowboat
Rubs & Liquids, Pain Relieving
Rug Cleaners
Rugs
Rum
Run-Down, Tired Feeling
Running, Distance
Running or Jogging
Running or Jogging Shoes
Rustproofing (Cars)
Rye or Blended Whiskey

S

Sabre/Jig Saw
Safe Deposit Box
Sailing
Salad Dressing
Salad Oil or Cooking Oil
Salted Crackers & Flavored Snack Crackers
Salt Water Fishing
Salt Water Fishing Reel
Salt Water Fishing Rod
Sander, Electric
Sandwich or Food Bags, Plastic
Sangria/Pop/Party Wines
Sanitary Napkins & Pads
Sauces, Bottled Barbecue & Seasoning
Sauce, Spaghetti
Sausages, Pork
Savings Account
Savings Certificates/Certificates of Deposit
Saw, Arm/Radial, Stationary
Saw, Chain

Saw, Circular
Saw, Jig/Sabre
School or College Board Membership
Scotch Whisky
Scouring Pads
Scouring Powder
Sculpting, Painting, Drawing
Seasoning & Barbecue Sauces, Bottled
Second Mortgage
Securities
Seeds
Self-Concept
Separate Electric Clothes Dryer
Separate Gas Clothes Dryer
Separate Home Freezer
Separate Microwave Oven
Separate Room Air Conditioer
Separate Room Heating Unit
Sewing
Sewing Machine
Sewing Materials & Notions
Shampoo
Shampoo, Baby
Shave Lotion (After-Shave) & Cologne
Shave Lotion, Pre-Electric
Shavers, Disposable
Shavers, Electric or Battery
Shaving
Shaving Cream or Gel
Sheets
Sheet Vinyl Flooring
Sherbet, Ice Cream & Ice Milk
Sherry, Port & Dessert Wines
Shirt/Blouse, Women's
Shirt, Regular or Dress, Men's
Shirt, Sport, Men's
Shock Absorbers
Shoes, Bowling
Shoes, Canvas
Shoes, Children's
Shoes, Golf
Shoes, Jogging or Running
Shoes, Leather
Shoes, Tennis
Shopping, Grocery, Weekly Expenditure
Shopping, Supermarket & Food
Shotgun For Hunting
Silver Flatware
Silver/Silver Coins
Sinus Congestion
Sinus Headache
Skating, Ice
Skating, Roller
Ski Boots
Ski Clothes
Skiing, Cross Country Snow
Skiing, Downhill Snow
Skiing, Water
Skin Care Products, Medicated
Skin Diving or Snorkeling
Skirt
Skis, Snow
Skis, Water
Slacks
Sleeplessness
Sleepwear, Children's
Slide Projector
Silo
Smoke/Fire Detector
Snack Crackers, Flavored & Salted Crackers
Snacks, Corn & Tortilla, & Chips
Sneakers
Snorkeling or Skin Diving
Snow Blower
Snowmobile
Snow Skiing, Cross Country
Snow Skiing, Downhill
Snow Skis
Snuff
Soaps & Detergents for Fine Fabrics
Soaps & Detergents for Regular Laundry
Soap, Toilet
Socks
Sofa Bed
Soft Drinks, Carbonated
Soft Drinks, Powdered
Softeners, Fabric
Solar Heating
Sore Throats
Soup, Canned
Soup, Dry Mix, & Bouillon Cubes
Spaghetti & Macaroni Products, Canned
Spaghetti Sauce
Sparkling Wines, Champagne & Cold Duck
Spark Plugs
Speaker, Stereo
Specialty & Aperitif Wines
Sporting Goods
Sport Jacket (Suit Type)
Sports Events Attendance
Sport Shirt, Men's
Sports & Leisure
Sports, Radio Listening
Sports, TV Watching
Sport/Utility Vehicles
Spot Removers
Sprays, Air Fresheners & Room Deodorizers
Spray, Non-Stick Cooking
Spread Cheese
Spring & Mineral Water, Bottled
Squash
Stainless Steel Flatware
Stain & Paint, Exterior House
Stamp Collecting
Stationary Bench/Table Circular Saw
Stationary Jig/Sabre Saw
Stationary Radial/Arm Saw
Steak Houses & Family Restaurants
Steam Cooker, Electric
Stereo, Compact or Console
Stereo Head Phones
Stereo Receiver/Tuner/Amplifier (All In One)
Stereo Speaker
Sterling Silver Flatware
Stern Drive Boat
Still Cameras
Stockings or Hose
Stocks
Stomach Remedies & Indigestion Aids
Stores, Convenience, & Supermarkets
Stores, Department & Discount
Stores, Health Food
Storm Doors or Windows
Stove/Heater, Wood Burning
Stove or Range, Electric
Stove or Range, Gas
Sugar, Brown & Granulated White
Suit, Leisure or Casual
Suit, Lightweight or Summer
Suit, Pants, Women's
Suits or Dresses, Children's
Suit, Swimming
Suit, Warm-Up
Suit, Winter or All-Year
Suit, Women's
Sunglasses
Sunscreen & Suntan Products
Suppositories & Douches, Feminine Hygiene
Swabs, Cotton
Sweater
Swimming
Swimming Pool
Swim Suit
Syrup, Pancake & Table

T

Table/Bench Circular Saw, Stationary
Tampons
Tape Cartridges, Blank
Tape Cartridges, Pre-Recorded
Tape Cassette, Blank
Tape Cassette, Pre-Recorded
Tape Player/Recorder, Reel-To-Reel
Tape & Record Clubs
Tape Reel, Blank
Tape Reel, Pre-Recorded
Tapes & Records: Types Bought
Target Gun
Target Shooting
Tea, Canned
Tea, Instant
Tea Mix, Iced, Instant
Tea, Regular
Telegrams & Wires
Telephones
Television Sets
Tennis
Tennis Balls
Tennis Clothing
Tennis Courts
Tennis, Platform
Tennis Racquet
Tennis Shoes
Tension, Nervous
Tent Camper, Towable Folding
Tequila
Theme Parks
Throat Lozenges, Medicated
Tick & Flea Care Products for Dogs & Cats
Tile, Ceiling, Residential
Tile, Floor
Tiller, Garden
Tired, Run-Down Feeling
Tires, Car, Truck & Van
Tissues, Facial
Tobacco, Chewing
Tobacco, Pipe
Toilet Bowl Cleaners
Toilet Paper
Toilet Soap
Tomato & Vegetable Juices
Tonic, Hair, or Hair Dressing
Tool Outfit, Hand
Toothache

Toothbrush, Electric
Toothpaste
Topping, Whipped
Tortilla & Corn Chips & Snacks
Tour Package
Towable Folding Tent Camper
Towable Mobile Home
Towable Travel or Camp Trailer
Towels
Towels, Paper
Toys & Games
Tractor, Garden
Tractor-Type/Riding Lawn Mower
Trailer, Towable Travel or Camper
Transmission Services
Trash Can Liners & Garbage Bags, Plastic
Trash Compactor, Electric
Travel Agent
Travel, Domestic
Travelers Checks
Travel, Foreign
Travel Insurance
Travel or Camper Trailer, Towable
Travel, Weekly
Treasury Notes
Treats, Dog, or Biscuits
Trips, Camping
Trips, Domestic Travel
Trips, Foreign Travel
Truck Driving, Reasons For
Truck Mounted Camper
Trucks
Trust Agreement With Bank
T-Shirt, Women's
Tuna, Canned
Tuner/Amplifier/Receiver, Stereo
Tupperwear
Turntable
TV Dinners (Frozen Complete Dinners)
TV Sets
TV Special Programs, Frequency of Watching
TV Sports, Frequency of Watching
Typewriter, Electric Portable

U

Underwear, Children's
Union Membership
Upset Stomach or Indigestion
Upset Stomach Remedies & Indigestion Aids
Utility/Sport Vehicle

V

Vacation/Weekend Home
Vaginal or Rectal Itching
Vans
Vegetable & Flower Seeds
Vegetables, Canned or Jarred
Vegetables, Frozen (Excluding Potatoes)
Vegetable & Tomato Juices
Vehicle, Camping
Vehicle, Sport/Utility
Vermouth
Veterans Club Membership
Video Cassette Recorder/Player
Video Game
Vinyl Flooring, Sheet
Vision Care Insurance
Vitamins for Children
Vitamin Tablets, Capsules & Liquids
Vodka
Voting

W

Wall, Floor or Ceiling Insulation
Wall Paint, Interior
Wall Paneling
Wall Paper
Wall-To-Wall Carpeting or Room Sized Rugs
Warm-Up Suit
Washing Machine, Automatic
Washloads of Laundry
Water Filter or Purifier
Water Heater
Water, Mineral & Spring, Bottled
Water Skiing
Water Skis
Wax & Polish, Car
Wax & Polish, Floor
Weekend /Vacation Home
Weekly Expenditure on Groceries
Weekly Travel
Whipped Topping
Whiskey, Bourbon
Whiskey, Irish
Whiskey, Rye or Blended
Whiskey, Canadian
Whiskey, Scotch
Wieners & Frankfurters
Window Cleaners
Windows, Storm, or Door
Wines, Aperitif & Specialty
Wines, Dessert, Port & Sherry
Wines, Domestic Dinner/Table
Wines, Imported Dinner/Table
Wines, Pop/Party/Sangria
Wines, Sparkling, Champagne & Cold Duck
Wipes, Cleansing, Pre-Moistened, For Babies
Wires & Telegrams
Wood Burning Stove/Heater
Woodworking
Wrap, Kitchen, Plastic-Type
Wristwatch, Digital Face
Wristwatch, Dial Face

Y

Yard Trimmer
Yellow Pages
Yogurt
Yogurt, Frozen

Source: Reprinted from SMRB 1982.

The information provided for each product in each volume is divided into three sections: usage, types, and brands. In each section, demographic information on the buyer of the product is presented: age, race, employment, education, place of residence (i.e., metropolitan central city, metropolitan suburban, and non-metropolitan), income, and household occupant characteristics. Usage of products by individuals and households is subdivided into "heavy," "medium," or "light." Table 21 lists an example of a hypothetical product usage calculation as performed by SMRB. The "heavy," "medium," and "light" designations are not absolute. They are based on the relative frequency of use of each product; the designations therefore vary from product to product. The usage rates are defined by SMRB for each product, and a table such as Table 21 is generated for each SMRB product. This information is particularly valuable for enumerating populations that may have high, medium, or low exposure to chemical substances via the use of consumer products when the same usage rates for product consumption are used to predict exposure levels. Table 22 is a sample table of SMRB usage data for rug cleaners. SMRB also presents the same demographic data according to product types (e.g., a rug cleaner may be marketed as a liquid, an aerosol, or a powder). Table 23 is a sample table of SMRB data for different types of rug cleaners purchased by female homemakers. Finally, SMRB also presents demographic data for specific name brands of products. Table 24 is a sample table of SMRB data for different name brand rug cleaners purchased by female homemakers.

SMRB presents data according to the characteristics of the buyer only. For example, for many consumer products the principal purchaser (as determined by the SMRB national consumer panel) may be the "female homemaker."* SMRB therefore only presents data for that product for the female homemaker. Six population groups are assumed to represent principal purchasers: adults, males, females, professional/managerial, female homemakers, and mothers. Furthermore, SMRB only reports data for populations 18 years of age and older. The implications of these factors cannot always be quantified.

Users of a product can be enumerated as the total number of users, or they can be disaggregated by brand or type of product. Figure 20 illustrates the SMRB presentation of data on usage of toothpaste by females. The first number in Column A under "all users" indicates that 75,174,000 females use toothpaste; this represents 92.7 percent of all

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* The term "female homemaker" is defined by SMRB as adult women who assume responsibility for the maintenance of a household. The term includes working women and women living alone as well as in families, and represents over 90 percent of adult women. It should be recognized that products bought and used by female homemakers are often purchased and used by males maintaining households. SMRB does not adjust for this limitation; resultant population data may therefore be somewhat underestimated.

Table 21. Product Usage Categorization for SMRB "Heavy," "Medium," and "Light" Designations

Number used in household in last 7 days[a]	HML[b] designation	Assigned weight	x	Product users (X1000[c])	=	Weighted consumption (X1000)	Percent of consumption	Percent of users[d]
10 or more	H	10.0		5,309		53,090.0	30.6	18.7 heavy
8-9	H	8.5		4,341		36,898.0	21.3	15.3
6-7	M	6.5		5,078		33,007.0	19.0	17.9 medium
5	M	5.0		3,941		19,705.0	11.3	13.9
4	L	4.0		5,172		20,688.0	11.9	18.2
3	L	3.0		1,556		4,668.0	2.7	5.5
2	L	2.0		2,691		5,382.0	3.1	9.5 light
1 or less	L	0.5		329		164.5	0.1	1.2
none	L	0		19		0	0.0	0.1
				28,436		173,603.0	100.0	100.3

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[a] Information provided by respondents to questionnaires.

[b] H = heavy
M = medium
L = light

[c] Responses are aggregated by each use level and totaled.

[d] Data as it appears in SMRB reports.

Source: SMRB (1981).

Table 22. Example of 1982 SMRB Data: Demographic Variables for Usage of Rug Cleaners Purchased by Female Homemakers

	TOTAL U S '000	ALL USERS				HEAVY USERS				MEDIUM USERS				LIGHT USERS			
		A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
		'000	% DOWN	% ACROSS	INDX	'000	% DOWN	% ACROSS	INDX	'000	% DOWN	% ACROSS	INDX	'000	% DOWN	% ACROSS	INDX
TOTAL FEMALE HOMEMAKERS	77506	36879	100.0	47.6	100	13063	100.0	16.9	100	10034	100.0	12.9	100	13783	100.0	17.8	100
18 - 24	9335	3750	10.2	40.2	84	1417	10.8	15.2	90	898	8.9	9.6	74	1435	10.4	15.4	86
25 - 34	18029	8934	24.2	49.6	104	3293	25.2	18.3	108	2362	23.5	13.1	101	3279	23.8	18.2	102
35 - 44	13417	7073	19.2	52.7	111	2275	17.4	17.0	101	1945	19.4	14.5	112	2853	20.7	21.3	120
45 - 54	11632	5753	15.6	49.5	104	2222	17.0	19.1	113	1492	14.9	12.8	99	2040	14.8	17.5	99
55 - 64	11283	5679	15.4	50.3	106	1867	14.3	16.5	98	1729	17.2	15.3	118	2084	15.1	18.5	104
65 OR OLDER	13811	5689	15.4	41.2	87	1988	15.2	14.4	85	1608	16.0	11.6	90	2093	15.2	15.2	85
18 - 34	27364	12685	34.4	46.4	97	4710	36.1	17.2	102	3260	32.5	11.9	92	4714	34.2	17.2	97
18 - 49	46197	22535	61.1	48.8	103	7966	61.0	17.2	102	5972	59.5	12.9	100	8596	62.4	18.6	105
25 - 54	43078	21760	59.0	50.5	106	7791	59.6	18.1	107	5799	57.8	13.5	104	8171	59.3	19.0	107
35 - 45	18833	9850	26.7	52.3	110	3256	24.9	17.3	103	2712	27.0	14.4	111	3882	28.2	20.6	116
50 OR OLDER	31310	14345	38.9	45.8	96	5096	39.0	16.3	97	4062	40.5	13.0	100	5187	37.6	16.6	93
GRADUATED COLLEGE	9890	5021	13.6	50.8	107	1451	11.1	14.7	87	1209	12.0	12.2	94	2361	17.1	23.9	134
ATTENDED COLLEGE	12236	5798	15.7	47.4	100	1878	14.4	15.3	91	1788	17.8	14.6	113	2131	15.5	17.4	98
GRADUATED HIGH SCHOOL	32853	16490	44.7	50.2	105	5649	43.2	17.2	102	4617	46.0	14.1	109	6224	45.2	18.9	107
DID NOT GRADUATE HIGH SCHOOL	22527	9571	26.0	42.5	89	4084	31.3	18.1	108	2420	24.1	10.7	83	3067	22.3	13.6	77
EMPLOYED	37446	18217	49.4	48.6	102	6306	48.3	16.8	100	4818	48.0	12.9	99	7093	51.5	18.9	107
EMPLOYED FULL-TIME	29717	14146	38.4	47.6	100	5002	38.3	16.8	100	3638	36.3	12.2	95	5507	40.0	18.5	104
EMPLOYED PART-TIME	7729	4071	11.0	52.7	111	1304	10.0	16.9	100	1180	11.8	15.3	118	1586	11.5	20.5	115
NOT EMPLOYED	40060	18662	50.6	46.6	98	6756	51.7	16.9	100	5216	52.0	13.0	101	6690	48.5	16.7	94
PROFESSIONAL/MANAGER	10614	5355	14.5	50.5	106	1666	12.8	15.7	93	1448	14.4	13.6	105	2242	16.3	21.1	119
CLERICAL/SALES	14780	6964	18.9	47.1	99	2342	17.9	15.8	94	1863	18.6	12.6	97	2760	20.0	18.7	105
CRAFTSMEN/FOREMEN	824	•429	1.2	52.1	109	••166	1.3	20.1	120	••174	1.7	21.1	163	••89	0.6	10.8	61
OTHER EMPLOYED	11229	5468	14.8	48.7	102	2133	16.3	19.0	113	1333	13.3	11.9	92	2002	14.5	17.8	100
SINGLE	8267	3220	8.7	39.0	82	1171	9.0	14.2	84	947	9.4	11.5	88	1101	8.0	13.3	75
MARRIED	50768	25994	70.5	51.2	108	8935	68.4	17.6	104	6981	69.6	13.8	106	10079	73.1	19.9	112
DIVORCED/SEPARATED/WIDOWED	18471	7666	20.8	41.5	87	2956	22.6	16.0	95	2106	21.0	11.4	88	2603	18.9	14.1	79
PARENTS	31500	16214	44.0	51.5	108	5773	44.2	18.3	109	4400	43.9	14.0	108	6041	43.8	19.2	108
WHITE	67876	32560	88.3	48.0	101	10982	84.1	16.2	96	8830	88.0	13.0	100	12748	92.5	18.8	106
BLACK	8235	3573	9.7	43.4	91	1780	13.6	21.6	128	1007	10.0	12.2	94	786	5.7	9.5	54
OTHER	1395	•746	2.0	53.5	112	••301	2.3	21.6	128	••197	2.0	14.1	109	••249	1.8	17.8	100
NORTHEAST-CENSUS	16922	7815	21.2	46.2	97	2960	22.7	17.5	104	2196	21.9	13.0	100	2660	19.3	15.7	88
NORTH CENTRAL	20200	10219	27.7	50.6	106	3252	24.9	16.1	96	3147	31.4	15.6	120	3820	27.7	18.9	106
SOUTH	26132	12341	33.5	47.2	99	4897	37.5	18.7	111	2904	28.9	11.1	86	4540	32.9	17.4	98
WEST	14252	6505	17.6	45.6	96	1955	15.0	13.7	81	1787	17.8	12.5	97	2764	20.1	19.4	109
NORTHEAST-MKTG.	17524	7849	21.3	44.8	94	2928	22.4	16.7	99	2084	20.8	11.9	92	2837	20.6	16.2	91
EAST CENTRAL	11814	6552	17.8	55.5	117	2331	17.8	19.7	117	2034	20.3	17.2	133	2188	15.9	18.5	104
WEST CENTRAL	13479	6542	17.7	48.5	102	1862	14.3	13.8	82	2056	20.5	15.3	118	2624	19.0	19.5	109
SOUTH	22875	10727	29.1	46.9	99	4306	33.0	18.8	112	2512	25.0	11.0	85	3908	28.4	17.1	96
PACIFIC	11814	5210	14.1	44.1	93	1635	12.5	13.8	82	1349	13.4	11.4	88	2226	16.2	18.8	106
COUNTY SIZE A	31229	14084	38.2	45.1	95	5024	38.5	16.1	95	3540	35.3	11.3	88	5520	40.0	17.7	99
COUNTY SIZE B	23352	11373	30.8	48.7	102	3958	30.3	16.9	101	3014	30.0	12.9	100	4401	31.9	18.8	106
COUNTY SIZE C	12137	6335	17.2	52.2	110	2249	17.2	18.5	110	1887	15.8	15.5	120	2199	16.0	18.1	102
COUNTY SIZE D	10789	5087	13.8	47.1	99	1832	14.0	17.0	101	1593	15.9	14.8	114	1663	12.1	15.4	87
METRO CENTRAL CITY	23359	9906	26.9	42.4	89	3558	27.2	15.2	90	2819	28.1	12.1	93	3529	25.6	15.1	85
METRO SUBURBAN	34657	17101	46.4	49.3	104	5690	43.6	16.4	97	4174	41.6	12.0	93	7236	52.5	20.9	117
NON METRO	19491	9872	26.8	50.6	106	3814	29.2	19.6	116	3040	30.3	15.6	120	3018	21.9	15.5	87
TOP 5 ADI'S	17725	7990	21.7	45.1	95	3040	23.3	17.2	102	2110	21.0	11.9	92	2840	20.6	16.0	90
TOP 10 ADI'S	25079	11418	31.0	45.5	96	4394	33.6	17.5	104	2996	29.9	11.9	92	4028	29.2	16.1	90
TOP 20 ADI'S	35085	16056	43.5	45.8	96	5947	45.5	17.0	101	4114	41.0	11.7	91	5996	43.5	17.1	96
HSHLD INC $40.000 OR MORE	8818	4450	12.1	50.5	106	1340	10.3	15.2	90	1190	11.9	13.5	104	1920	13.9	21.8	122
$30 000 OR MORE	18653	9421	25.5	50.5	106	2733	20.9	14.7	87	2614	26.1	14.0	108	4074	29.6	21.8	123
$25 000 OR MORE	25911	13098	35.5	50.5	106	4094	31.3	15.8	94	3503	34.9	13.5	104	5502	39.9	21.2	119
$20.000 - $24.999	9349	4643	12.6	49.7	104	1562	12.0	16.7	99	1340	13.4	14.3	111	1742	12.6	18.6	105
$15 000 - $19 999	8862	4580	12.4	51.7	109	1543	11.8	17.4	103	1191	11.9	13.4	104	1846	13.4	20.8	117
$10.000 - $14.999	13844	6572	17.8	47.5	100	2304	17.6	16.6	99	1822	18.2	13.2	102	2447	17.8	17.7	99
UNDER $10 000	19541	7985	21.7	40.9	86	3561	27.3	18.2	108	2179	21.7	11.2	86	2246	16.3	11.5	65
HOUSEHOLD OF 1 PERSON	11894	4657	12.6	39.2	82	1722	13.2	14.5	86	1302	13.0	10.9	85	1634	11.9	13.7	77
2 PEOPLE	25454	11362	30.8	44.6	94	4102	31.4	16.1	96	2816	28.1	11.1	85	4445	32.2	17.5	98
3 OR 4 PEOPLE	28521	14790	40.1	51.9	109	4822	36.9	16.9	100	4378	43.6	15.4	119	5590	40.6	19.6	110
5 OR MORE PEOPLE	11637	6070	16.5	52.2	110	2418	18.5	20.8	123	1538	15.3	13.2	102	2114	15.3	18.2	102
NO CHILD IN HSHLD	43986	19806	53.7	45.0	95	6936	53.1	15.8	94	5306	52.9	12.1	93	7564	54.9	17.2	97
CHILD(REN) UNDER 2 YRS	5651	2706	7.3	47.9	101	1022	7.8	18.1	107	723	7.2	12.8	99	961	7.0	17.0	96
2 - 5 YEARS	12521	6469	17.5	51.7	109	2532	19.4	20.2	120	1697	16.9	13.6	105	2240	16.3	17.9	101
6 - 11 YEARS	15766	8603	23.3	54.6	115	3074	23.5	19.5	116	2451	24.4	15.5	120	3079	22.3	19.5	110
12 - 17 YEARS	16144	8366	22.7	51.8	109	3017	23.1	18.7	111	2200	21.9	13.6	105	3150	22.9	19.5	110
RESIDENCE OWNED	55460	28352	76.9	51.1	107	9424	72.1	17.0	101	7775	77.5	14.0	108	11154	80.9	20.1	113
VALUE $50 000 OR MORE	28563	14704	39.9	51.5	108	4632	35.5	16.2	96	3769	37.6	13.2	102	6303	45.7	22.1	124
VALUE UNDER $50 000	26857	13648	37.0	50.7	107	4792	36.7	17.8	106	4006	39.9	14.9	115	4851	35.2	18.0	101

Source: SMRB 1982.

Table 23. Example of 1982 SMRB Data: Demographic Variables for Types of Rug Cleaners Purchased by Female Homemakers

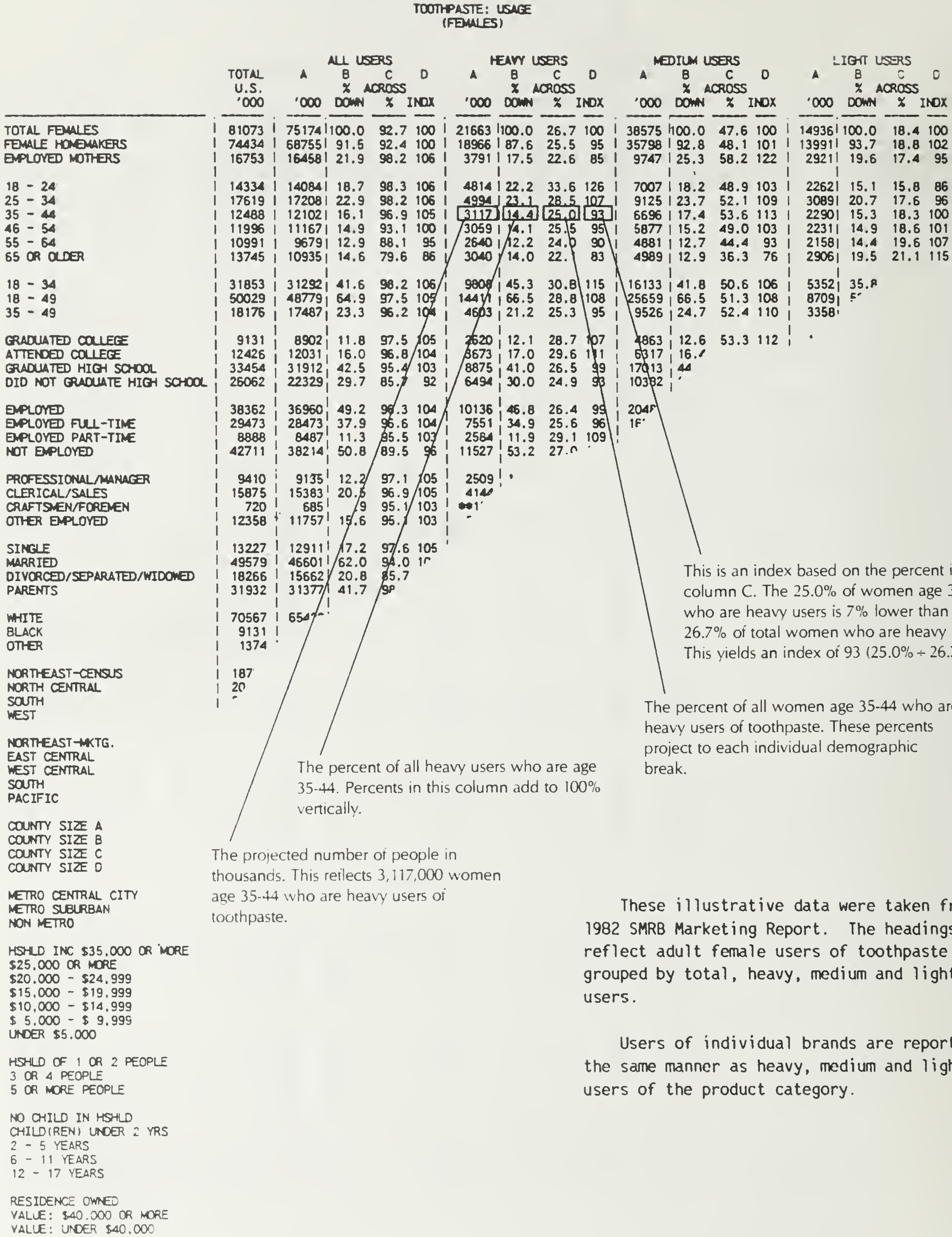
	TOTAL	LIQUID				AEROSOL				POWDER/GRANULES							
	U S '000	A '000	B % DOWN	C % ACROSS	D INDX	A '000	B % DOWN	C % ACROSS	D INDX	A '000	B % DOWN	C % ACROSS	D INDX	A '000	B % DOWN	C % ACROSS	D INDX
TOTAL FEMALE HOMEMAKERS	77506	18939	100.0	24.4	100	13862	100.0	17.9	100	6044	100.0	7.8	100				
18 - 24	9335	1706	9.0	18.3	75	1746	12.6	18.7	105	813	13.5	8.7	112				
25 - 34	18029	4515	23.8	25.0	102	3855	27.8	21.4	120	1442	23.9	8.0	103				
35 - 44	13417	4241	22.4	31.6	129	2351	17.0	17.5	98	976	16.1	7.3	93				
45 - 54	11632	2903	15.3	25.0	102	2232	16.1	19.2	107	842	13.9	7.2	93				
55 - 64	11283	2903	15.3	25.7	105	2136	15.4	18.9	106	888	14.7	7.9	101				
65 OR OLDER	13811	2673	14.1	19.4	79	1543	11.1	11.2	62	1083	17.9	7.8	101				
18 - 34	27364	6221	32.8	22.7	93	5601	40.4	20.5	114	2255	37.3	8.2	106				
18 - 49	46197	11914	62.9	25.8	106	9058	65.3	19.6	110	3598	59.5	7.8	100				
25 - 54	43078	11658	61.6	27.1	111	8437	60.9	19.6	110	3260	53.9	7.6	97				
35 - 49	18833	5694	30.1	30.2	124	3458	24.9	18.4	103	1343	22.2	7.1	91				
50 OR OLDER	31310	7025	37.1	22.4	92	4803	34.6	15.3	86	2446	40.5	7.8	100				
GRADUATED COLLEGE	9890	2535	13.4	25.6	105	2008	14.5	20.3	114	772	12.8	7.8	100				
ATTENDED COLLEGE	12236	2955	15.6	24.2	99	2719	19.6	22.2	124	911	15.1	7.4	95				
GRADUATED HIGH SCHOOL	32853	8311	43.9	25.3	104	6521	47.0	19.8	111	2718	45.0	8.3	106				
DID NOT GRADUATE HIGH SCHOOL	22527	5139	27.1	22.8	93	2613	18.9	11.6	65	1642	27.2	7.3	93				
EMPLOYED	37446	9264	48.9	24.7	101	7069	51.0	18.9	106	3178	52.6	8.5	109				
EMPLOYED FULL-TIME	29717	7254	38.3	24.4	100	5431	35.2	18.3	102	2346	38.8	7.9	101				
EMPLOYED PART-TIME	7729	2010	10.6	26.0	106	1638	11.8	21.2	118	832	13.8	10.8	138				
NOT EMPLOYED	40060	9676	51.1	24.2	99	6792	49.0	17.0	95	2866	47.4	7.2	92				
PROFESSIONAL/MANAGER	10614	2665	14.1	25.1	103	2169	15.6	20.4	114	707	11.7	6.7	85				
CLERICAL/SALES	14780	3542	18.7	24.0	98	2903	20.9	19.6	110	1119	18.5	7.6	97				
CRAFTSMEN/FOREMEN	824	••222	1.2	26.9	110	••125	0.9	15.2	85	••45	0.7	5.5	70				
OTHER EMPLOYED	11229	2836	15.0	25.3	103	1872	13.5	16.7	93	1306	21.6	11.8	145				
SINGLE	8267	1370	7.2	16.6	68	1504	10.8	18.2	102	657	10.9	7.9	102				
MARRIED	50768	13940	73.6	27.5	112	9881	71.3	19.5	109	3927	65.0	7.7	99				
DIVORCED/SEPARATED/WIDOWED	18471	3629	19.2	19.6	80	2477	17.9	13.4	75	1460	24.2	7.9	101				
PARENTS	31500	9208	48.6	29.2	120	5946	42.9	18.9	106	2427	40.2	7.7	99				
WHITE	67876	16584	87.6	24.4	100	12547	90.5	18.5	103	5106	84.5	7.5	96				
BLACK	8235	1890	10.0	23.0	94	1128	8.1	13.7	77	713	11.8	8.7	111				
OTHER	1395	••465	2.5	33.3	136	••186	1.3	13.3	75	••225	3.7	16.1	207				
NORTHEAST-CENSUS	16922	4035	21.3	23.8	98	3054	22.0	18.0	101	1164	19.3	6.9	88				
NORTH CENTRAL	20200	5505	29.1	27.3	112	3744	27.0	18.5	104	1481	24.5	7.3	94				
SOUTH	26132	6098	32.2	23.3	95	4337	31.3	16.6	93	2465	40.8	9.4	121				
WEST	14252	3302	17.4	23.2	95	2727	19.7	19.1	107	935	15.5	6.6	84				
NORTHEAST-MKTG	17524	3718	19.6	21.2	87	3129	22.6	17.9	100	1276	21.1	7.3	93				
EAST CENTRAL	11814	3853	20.3	32.6	133	2259	16.3	19.1	107	922	15.3	7.8	100				
WEST CENTRAL	13479	3326	17.6	24.7	101	2410	17.4	17.9	100	963	15.9	7.1	92				
SOUTH	22875	5486	29.0	24.0	98	3731	26.9	16.3	91	2138	35.4	9.3	120				
PACIFIC	11814	2557	13.5	21.6	89	2333	16.8	19.7	110	746	12.3	6.3	81				
COUNTY SIZE A	31229	6495	34.3	20.8	85	5905	42.6	18.9	106	2398	39.7	7.7	98				
COUNTY SIZE B	23352	5970	31.5	25.6	105	4283	30.9	18.3	103	1922	31.8	8.2	106				
COUNTY SIZE C	12137	3645	19.2	30.0	123	2065	14.9	17.0	95	893	14.8	7.4	94				
COUNTY SIZE D	10789	2830	14.9	26.2	107	1609	11.6	14.9	83	832	13.8	7.7	99				
METRO CENTRAL CITY	23359	4717	24.9	20.2	83	4027	29.1	17.2	96	1916	31.7	8.2	105				
METRO SUBURBAN	34657	8726	46.1	25.2	103	6521	47.0	18.8	105	2610	43.2	7.5	97				
NON METRO	19491	5496	29.0	28.2	115	3313	23.9	17.0	95	1519	25.1	7.8	100				
TOP 5 ADI'S	17725	3820	20.2	21.6	88	3227	23.3	18.2	102	1316	21.8	7.4	95				
TOP 10 ADI'S	25079	5347	28.2	21.3	87	4854	35.0	19.4	108	1829	30.3	7.3	94				
TOP 20 ADI'S	35085	7556	39.9	21.5	88	6725	48.5	19.2	107	2717	45.0	7.7	99				
HSHLD INC $40.000 OR MORE	8818	2487	13.1	28.2	115	1849	13.3	21.0	117	•470	7.8	5.3	68				
$30.000 OR MORE	18653	5129	27.1	27.5	113	3747	27.0	20.1	112	1232	20.4	6.6	85				
$25.000 OR MORE	25911	6963	36.8	26.9	110	5491	39.6	21.2	118	1869	30.9	7.2	92				
$20.000 - $24.999	9349	2357	12.4	25.2	103	1964	14.2	21.0	117	685	11.3	7.3	94				
$15.000 - $19.999	8862	2571	13.6	29.0	119	1563	11.3	17.6	99	790	13.1	8.9	114				
$10.000 - $14.999	13844	3115	16.4	22.5	92	2542	18.3	18.4	103	1023	16.9	7.4	95				
UNDER $10.000	19541	3933	20.8	20.1	82	2302	16.6	11.8	66	1677	27.7	8.6	110				
HOUSEHOLD OF 1 PERSON	11894	1856	9.8	15.6	64	1566	11.3	13.2	74	958	15.9	8.1	103				
2 PEOPLE	25454	5550	29.3	21.8	89	4392	31.7	17.3	96	1862	30.8	7.3	94				
3 OR 4 PEOPLE	28521	8036	42.4	28.2	115	5878	42.4	20.6	115	2331	38.6	8.2	105				
5 OR MORE PEOPLE	11637	3497	18.5	30.1	123	2026	14.6	17.4	97	893	14.8	7.7	98				
NO CHILD IN HSHLD	43986	9224	48.7	21.0	86	7685	55.4	17.5	98	3448	57.0	7.8	101				
CHILD(REN) UNDER 2 YRS	5651	1421	7.5	25.1	103	1153	8.3	20.4	114	•367	6.1	6.5	83				
2 - 5 YEARS	12521	3542	18.7	28.3	116	2634	19.0	21.0	118	890	14.7	7.1	91				
6 - 11 YEARS	15766	5149	27.2	32.7	134	3155	22.8	20.0	112	1193	19.7	7.6	97				
12 - 17 YEARS	16144	4940	26.1	30.6	125	2542	18.3	15.7	88	1412	23.4	8.7	112				
RESIDENCE OWNED	55460	15154	80.0	27.3	112	10322	74.5	18.6	104	4313	71.4	7.8	100				
VALUE $50.000 OR MORE	28563	7777	41.1	27.2	111	5721	41.3	20.0	112	2066	34.2	7.2	93				
VALUE UNDER $50.000	26897	7378	39.0	27.4	112	4602	33.2	17.1	96	2248	37.2	8.4	107				

Source: SMRB 1982.

Table 24. Example of 1982 SMRB Data: Demographic Variables for Brands of Rug Cleaners Purchased by Female Homemakers

	TOTAL	BLUE LUSTRE				GLAMORENE SPRAY 'N VAC				JOHNSON'S GLORY				WOOLITE			
	U.S	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
			% ACROSS				% ACROSS				% ACROSS				% ACROSS		
	'000	'000	DOWN	%	INDX	'000	DOWN	%	INDX	'000	DOWN	%	INDX	'000	DOWN	%	INDX
TOTAL FEMALE HOMEMAKERS	77506	7924	100.0	10.2	100	3872	100.0	5.0	100	4766	100.0	6.1	100	9154	100.0	11.8	100
18 - 24	9335	799	10.1	8.6	84	**301	7.8	3.2	65	802	16.8	8.6	140	1061	11.6	11.4	96
25 - 34	18029	1638	20.7	9.1	89	890	23.0	4.9	99	1303	27.3	7.2	118	2313	25.3	12.8	109
35 - 44	13417	1622	20.5	12.1	118	630	16.3	4.7	94	819	17.2	6.1	99	1116	12.2	8.3	70
45 - 54	11632	1363	17.2	11.7	115	674	17.4	5.8	116	602	12.6	5.2	84	1448	15.8	12.4	105
55 - 64	11283	1347	17.0	11.9	117	706	18.2	6.3	125	590	12.4	5.2	85	1520	16.6	13.5	114
65 OR OLDER	13811	1155	14.6	8.4	82	672	17.4	4.9	97	650	13.6	4.7	77	1695	18.5	12.3	104
18 - 34	27364	2436	30.7	8.9	87	1190	30.7	4.3	87	2105	44.2	7.7	125	3374	36.9	12.3	104
18 - 49	46197	4823	60.9	10.4	102	2155	55.7	4.7	93	3268	68.6	7.1	115	5191	56.7	11.2	95
25 - 54	43078	4623	58.3	10.7	105	2194	56.7	5.1	102	2724	57.2	6.3	103	4877	53.3	11.3	96
35 - 49	18833	2387	30.1	12.7	124	965	24.9	5.1	103	1163	24.4	6.2	100	1817	19.8	9.6	82
50 OR OLDER	31310	3101	39.1	9.9	97	1716	44.3	5.5	110	1498	31.4	4.8	78	3963	43.3	12.7	107
GRADUATED COLLEGE	9890	910	11.5	9.2	90	631	16.3	6.4	128	561	11.8	5.7	92	1287	14.1	13.0	110
ATTENDED COLLEGE	12236	1207	15.2	9.9	96	594	15.3	4.9	97	638	13.4	5.2	85	1715	18.7	14.0	119
GRADUATED HIGH SCHOOL	32853	3614	45.6	11.0	108	1728	44.6	5.3	105	2148	45.1	6.5	106	3861	42.2	11.8	100
DID NOT GRADUATE HIGH SCHOOL	22527	2194	27.7	9.7	95	920	23.8	4.1	82	1419	29.8	6.3	102	2290	25.0	10.2	86
EMPLOYED	37446	3998	50.5	10.7	104	1913	49.4	5.1	102	2640	55.4	7.1	115	4086	44.6	10.9	92
EMPLOYED FULL-TIME	29717	3073	38.8	10.3	101	1523	39.3	5.1	103	2014	42.3	6.8	110	3124	34.1	10.5	89
EMPLOYED PART-TIME	7729	924	11.7	12.0	117	*389	10.0	5.0	101	*626	13.1	8.1	132	961	10.5	12.4	105
NOT EMPLOYED	40060	3926	49.5	9.8	96	1959	50.6	4.9	98	2126	44.6	5.3	86	5068	55.4	12.7	107
PROFESSIONAL/MANAGER	10614	973	12.3	9.2	90	*604	15.6	5.7	114	565	11.9	5.3	87	1280	14.0	12.1	102
CLERICAL/SALES	14780	1610	20.3	10.9	107	743	19.2	5.0	101	1373	28.8	9.3	151	1616	17.7	10.9	93
CRAFTSMEN/FOREMEN	824	**201	2.5	24.4	239	**53	1.4	6.4	129	**16	0.3	1.9	32	**64	0.7	7.8	66
OTHER EMPLOYED	11229	1213	15.3	10.8	106	*512	13.2	4.6	91	687	14.4	6.1	99	1126	12.3	10.0	85
SINGLE	8267	630	8.0	7.6	75	*392	10.1	4.7	95	744	15.6	9.0	146	933	10.2	11.3	96
MARRIED	50768	5549	70.0	10.9	107	2623	67.7	5.2	103	3190	66.9	6.3	102	6171	67.4	12.2	103
DIVORCED/SEPARATED/WIDOWED	18471	1745	22.0	9.4	92	857	22.1	4.6	93	833	17.5	4.5	73	2049	22.4	11.1	94
PARENTS	31500	3519	44.4	11.2	109	1323	34.2	4.2	84	2137	44.8	6.8	110	3415	37.3	10.8	92
WHITE	67876	7125	89.9	10.5	103	3527	91.1	5.2	104	3932	82.5	5.8	94	8404	91.8	12.4	105
BLACK	8235	677	8.5	8.2	80	*331	8.5	4.0	80	784	16.4	9.5	155	634	6.9	7.7	65
OTHER	1395	**122	1.5	8.7	86	**14	0.4	1.0	20	**50	1.0	3.6	58	**116	1.3	8.3	70
NORTHEAST-CENSUS	16922	1364	17.2	8.1	79	945	24.4	5.6	112	841	17.6	5.0	81	1768	19.3	10.4	88
NORTH CENTRAL	20200	2656	33.5	13.1	129	1038	26.8	5.1	103	1365	28.6	6.8	110	2160	23.6	10.7	91
SOUTH	26132	2853	36.0	10.9	107	1256	32.4	4.8	96	2004	42.0	7.7	125	3349	36.6	12.8	109
WEST	14252	1051	13.3	7.4	72	*633	16.3	4.4	89	556	11.7	3.9	63	1876	20.5	13.2	111
NORTHEAST-MKTG	17524	1252	15.8	7.1	70	985	25.4	5.6	113	814	17.1	4.6	76	1707	18.6	9.7	82
EAST CENTRAL	11814	2054	25.9	17.4	170	551	14.2	4.7	93	928	19.5	7.9	128	1326	14.5	11.2	95
WEST CENTRAL	13479	1390	17.5	10.3	101	623	16.1	4.6	93	795	16.7	5.9	96	1427	15.6	10.6	90
SOUTH	22875	2569	32.4	11.2	110	1156	29.9	5.1	101	1831	38.4	8.0	130	3034	33.1	13.3	112
PACIFIC	11814	*659	8.3	5.6	55	*557	14.4	4.7	94	*398	8.4	3.4	55	1660	18.1	14.1	119
COUNTY SIZE A	31229	2168	27.4	6.9	68	1637	42.3	5.2	105	1534	32.2	4.9	80	3582	39.1	11.5	97
COUNTY SIZE B	23352	2593	32.7	11.1	109	1161	30.0	5.0	100	1763	37.0	7.5	123	2991	32.7	12.8	108
COUNTY SIZE C	12137	1614	20.4	13.3	130	*629	16.2	5.2	104	*617	12.9	5.1	83	1479	16.1	12.2	103
COUNTY SIZE D	10789	1548	19.5	14.3	140	445	11.5	4.1	83	852	17.9	7.9	128	1104	12.1	10.2	87
METRO CENTRAL CITY	23359	1800	22.7	7.7	75	995	25.7	4.3	85	1527	32.0	6.5	106	2933	32.0	12.6	106
METRO SUBURBAN	34657	3269	41.3	9.4	92	1890	48.8	5.5	109	1929	40.5	5.6	91	4101	44.8	11.8	100
NON METRO	19491	2855	36.0	14.6	143	987	25.5	5.1	101	1310	27.5	6.7	109	2119	23.1	10.9	92
TOP 5 ADI'S	17725	1017	12.8	5.7	56	1118	28.9	6.3	126	627	13.2	3.5	58	1871	20.4	10.6	89
TOP 10 ADI'S	25079	1700	21.5	6.8	66	1472	38.0	5.9	117	1108	23.2	4.4	72	2706	29.6	10.8	91
TOP 20 ADI'S	35085	2621	33.1	7.5	73	1942	50.2	5.5	111	1867	39.2	5.3	87	3995	43.6	11.4	96
HSHLD INC $40,000 OR MORE	8818	960	12.1	10.9	106	*460	11.9	5.2	104	*440	9.2	5.0	81	1208	13.2	13.7	116
$30,000 OR MORE	18653	2110	26.6	11.3	111	1086	28.0	5.8	117	1071	22.5	5.7	93	2099	22.9	11.3	95
$25,000 OR MORE	25911	2746	34.7	10.6	104	1649	42.6	6.4	127	1529	32.1	5.9	96	2903	31.7	11.2	95
$20,000 - $24,999	9349	868	11.0	9.3	91	*418	10.8	4.5	89	674	14.1	7.2	117	1242	13.6	13.3	112
$15,000 - $19,999	8862	1124	14.2	12.7	124	*354	9.1	4.0	80	*438	9.2	4.9	80	1042	11.4	11.8	100
$10,000 - $14,999	13844	1330	16.8	9.6	94	661	17.1	4.8	96	827	17.4	6.0	97	1818	19.9	13.1	111
UNDER $10,000	19541	1855	23.4	9.5	93	791	20.4	4.0	81	1299	27.3	6.6	108	2149	23.5	11.0	93
HOUSEHOLD OF 1 PERSON	11894	960	12.1	8.1	79	532	13.7	4.5	90	674	14.1	5.7	92	1668	18.2	14.0	119
2 PEOPLE	25454	2231	28.2	8.8	86	1300	33.6	5.1	102	1464	30.7	5.8	94	3221	35.2	12.7	107
3 OR 4 PEOPLE	28521	3411	43.0	12.0	117	1402	36.2	4.9	98	1932	40.5	6.8	110	2999	32.8	10.5	89
5 OR MORE PEOPLE	11637	1322	16.7	11.4	111	*638	16.5	5.5	110	697	14.6	6.0	97	1267	13.8	10.9	92
NO CHILD IN HSHLD	43986	4153	52.4	8.4	92	2386	61.6	5.4	109	2503	52.5	5.7	93	5650	61.7	12.8	109
CHILD(REN) UNDER 2 YRS	5651	*519	6.5	9.2	90	**260	6.7	4.6	92	*375	7.9	6.6	108	692	7.6	12.2	104
2 - 5 YEARS	12521	1108	14.0	8.8	87	*627	16.2	5.0	100	923	19.4	7.4	120	1409	15.4	11.3	95
6 - 11 YEARS	15766	1965	24.8	12.5	122	839	21.7	5.3	107	1252	26.3	7.9	129	1686	18.4	10.7	91
12 - 17 YEARS	16144	2230	28.1	13.8	135	646	16.7	4.0	80	961	20.2	6.0	97	1545	16.9	9.6	81
RESIDENCE OWNED	55460	6568	82.9	11.8	116	3000	77.5	5.4	108	3189	66.9	5.8	94	6973	76.2	12.6	106
VALUE $50,000 OR MORE	28563	2893	36.5	10.1	99	1544	39.9	5.4	108	1396	29.3	4.9	79	3766	41.1	13.2	112
VALUE UNDER $50,000	26897	3675	46.4	13.7	134	1457	37.6	5.4	108	1793	37.6	6.7	108	3207	35.0	11.9	101

Source: SMRB 1982.



TOOTHPASTE: USAGE
(FEMALES)

	TOTAL	ALL USERS				HEAVY USERS				MEDIUM USERS				LIGHT USERS			
	U.S.	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
			%	ACROSS			%	ACROSS			%	ACROSS			%	ACROSS	
	'000	'000	DOWN	%	INDX	'000	DOWN	%	INDX	'000	DOWN	%	INDX	'000	DOWN	%	INDX
TOTAL FEMALES	81073	75174	100.0	92.7	100	21663	100.0	26.7	100	38575	100.0	47.6	100	14936	100.0	18.4	100
FEMALE HOMEMAKERS	74434	68755	91.5	92.4	100	18966	87.6	25.5	95	35798	92.8	48.1	101	13991	93.7	18.8	102
EMPLOYED MOTHERS	16753	16458	21.9	98.2	106	3791	17.5	22.6	85	9747	25.3	58.2	122	2921	19.6	17.4	95
18 - 24	14334	14084	18.7	98.3	106	4814	22.2	33.6	126	7007	18.2	48.9	103	2262	15.1	15.8	86
25 - 34	17619	17208	22.9	98.2	106	4994	23.1	28.5	107	9125	23.7	52.1	109	3089	20.7	17.6	96
35 - 44	12488	12102	16.1	96.9	105	3117	14.4	25.0	93	6696	17.4	53.6	113	2290	15.3	18.3	100
46 - 54	11996	11167	14.9	93.1	100	3059	14.1	25.5	95	5877	15.2	49.0	103	2231	14.9	18.6	101
55 - 64	10991	9679	12.9	88.1	95	2640	12.2	24.0	90	4881	12.7	44.4	93	2158	14.4	19.6	107
65 OR OLDER	13745	10935	14.6	79.6	86	3040	14.0	22.	83	4989	12.9	36.3	76	2906	19.5	21.1	115
18 - 34	31853	31292	41.6	98.2	106	9808	45.3	30.8	115	16133	41.8	50.6	106	5352	35.8		
18 - 49	50029	48779	64.9	97.5	105	14411	66.5	28.8	108	25659	66.5	51.3	108	8709	5		
35 - 49	18176	17487	23.3	96.2	104	4603	21.2	25.3	95	9526	24.7	52.4	110	3358			
GRADUATED COLLEGE	9131	8902	11.8	97.5	105	2620	12.1	28.7	107	4863	12.6	53.3	112				
ATTENDED COLLEGE	12426	12031	16.0	96.8	104	3673	17.0	29.6	111	6317	16.						
GRADUATED HIGH SCHOOL	33454	31912	42.5	95.4	103	8875	41.0	26.5	99	17013	44						
DID NOT GRADUATE HIGH SCHOOL	26062	22329	29.7	85.7	92	6494	30.0	24.9	93	10382							
EMPLOYED	38362	36960	49.2	96.3	104	10136	46.8	26.4	99	204							
EMPLOYED FULL-TIME	29473	28473	37.9	96.6	104	7551	34.9	25.6	96	1							
EMPLOYED PART-TIME	8888	8487	11.3	95.5	103	2584	11.9	29.1	109								
NOT EMPLOYED	42711	38214	50.8	89.5	96	11527	53.2	27.									
PROFESSIONAL/MANAGER	9410	9135	12.2	97.1	105	2509											
CLERICAL/SALES	15875	15383	20.5	96.9	105	414											
CRAFTSMEN/FOREMEN	720	685	9	95.1	103	1											
OTHER EMPLOYED	12358	11757	15.6	95.1	103												
SINGLE	13227	12911	17.2	97.6	105												
MARRIED	49579	46601	62.0	94.0	1												
DIVORCED/SEPARATED/WIDOWED	18266	15662	20.8	85.7													
PARENTS	31932	31377	41.7	9													
WHITE	70567	654															
BLACK	9131																
OTHER	1374																
NORTHEAST-CENSUS	187																
NORTH CENTRAL	20																
SOUTH																	
WEST																	
NORTHEAST-MKTG.																	
EAST CENTRAL																	
WEST CENTRAL																	
SOUTH																	
PACIFIC																	
COUNTY SIZE A																	
COUNTY SIZE B																	
COUNTY SIZE C																	
COUNTY SIZE D																	
METRO CENTRAL CITY																	
METRO SUBURBAN																	
NON METRO																	
HSHLD INC $35,000 OR MORE																	
$25,000 OR MORE																	
$20,000 - $24,999																	
$15,000 - $19,999																	
$10,000 - $14,999																	
$ 5,000 - $ 9,999																	
UNDER $5,000																	
HSHLD OF 1 OR 2 PEOPLE																	
3 OR 4 PEOPLE																	
5 OR MORE PEOPLE																	
NO CHILD IN HSHLD																	
CHILD(REN) UNDER 2 YRS																	
2 - 5 YEARS																	
6 - 11 YEARS																	
12 - 17 YEARS																	
RESIDENCE OWNED																	
VALUE: $40,000 OR MORE																	
VALUE: UNDER $40,000																	

This is an index based on the percent in column C. The 25.0% of women age 35-44 who are heavy users is 7% lower than the 26.7% of total women who are heavy users. This yields an index of 93 (25.0% ÷ 26.7%).

The percent of all women age 35-44 who are heavy users of toothpaste. These percents project to each individual demographic break.

The percent of all heavy users who are age 35-44. Percents in this column add to 100% vertically.

The projected number of people in thousands. This reflects 3,117,000 women age 35-44 who are heavy users of toothpaste.

These illustrative data were taken from a 1982 SMRB Marketing Report. The headings reflect adult female users of toothpaste grouped by total, heavy, medium and light users.

Users of individual brands are reported in the same manner as heavy, medium and light users of the product category.

Figure 20. A Page From a Typical 1982 SMRB Marketing Report

Source: SMRB 1982.

females over 18 (Column C). To enumerate all users of toothpaste, one would consult the corresponding table for adults. That total would indicate the number of persons over 18 using toothpaste. The investigator must use judgment on a case-by-case basis to decide whether "adults" accurately represent the user population. In the case of toothpaste and similar hygiene products, census totals for persons between the ages of 1 and 17 should be added to the adult total derived from SMRB.

Examination of Tables 23 and 24 indicates the ease by which users of different brands or types of products can be enumerated. In most cases, the totals under Column A or the percentages in Column C are directly applicable to enumeration. Distinctions among adult users of different ages are easily made, if such distinction is required. Subsection 5.4.1 further discusses age and sex characterization of consumers using these data.

The SMRB data are clearly intended to describe the market variability of existing products. Consequently, the data are generally more applicable to existing chemicals and product formulations currently on the market than to new chemical substances. The SMRB data may, however, prove useful to assessments of PMN substances when the new chemical is intended for use as a substitute for an existing chemical. If use information included in a PMN submittal is sufficiently detailed, the SMRB data can be used to predict the number of exposed consumers. Method 5-2 summarizes the use of SMRB data for any chemical or product. Examples of the use of SMRB data are presented in Appendix A-4. That discussion provides clear methods for estimating the number of product users or the actively exposed population. Those who may be exposed to chemical residuals by their proximity to consumer products are passively exposed and are more difficult to enumerate accurately. Simmons' demographic data for households can be used toward this end, as illustrated in Method 5-2 and Appendix A-4.

The data set used to enumerate a product's users (by usage, type, or brand) also presents the frequency distribution of household size. For example, Table 22 indicates that 36,879,000 women use rug cleaners (Column A, all users, total female homemakers). Near the bottom of the page, still under Column A, are the numbers of households having 1, 2, 3 or 4, or 5 or more persons; these households also total approximately 36,879,000. To approximate the number of persons living in the 36,879,000 households, apply the frequency distribution and household size. Ranges can be used to accurately estimate the exposed population; use of the high end of the ranges generates a conservative estimate of exposed persons.

Method 5-2. Enumeration of Exposed Consumer Populations via the Use of Simmons Market Research Bureau Reports

Step 1 From the list of consumer products known to or thought to contain a chemical substance under investigation, identify those for which SMRB collects use data (Table 20). If SMRB does collect data, identify the appropriate product category volume(s) from Table 19.

Step 2 Identify applicable tables for enumeration as follows;

- If chemical substance is found in all types of products and brand names, the usage tables should be used.
- If chemical substance is found in only certain product types (e.g., aerosols versus liquids), the type tables should be used.
- If chemical substance is found in only certain brand names, the table on individual brand products should be used.

Step 3 Enumerate the actively exposed population as follows;

- If the exposed population is all adults and the data are available as such in SMRB, the column for all users (Column A) should be used. If the data are only available as adult males and adult females, the data in column A in each table should be added for the total exposed population. The investigator should decide whether children of less than 18 years of age are also actively exposed. If so, the age bracket should be determined and the total population in the U.S. for the age bracket should be obtained from Table 12 (Section 2.4). The adult percentage of users (Column C) should then be applied to the total number of children in the specified age bracket. The resulting population estimate should then be added to the total adult population for complete population enumeration.
- If only one member of the household is actively exposed, then the data for all users as listed for the product buyers (e.g., female homemakers) should be used to enumerate the exposed population.
- If the entire household is actively exposed but the SMRB data are only available for the type of buyer, the procedures to enumerate the exposed population are the same as the procedures to enumerate the passively exposed population described in Step 5.

Step 4 To enumerate the exposed population according to heavy, medium, or light exposure, the same procedures previously discussed are applicable; however, rather than using the column of data for all users, the columns of data for heavy, medium, and light users should be used. This should be done only when exposure levels are derived from the SMRB use patterns.

Step 5 To enumerate the passively exposed population, two approaches are possible. The second approach will provide a more accurate estimate. Both approaches assume that the actively exposed population will also be passively exposed.

Option 1 - Enumerate the actively exposed population as described in Step 3. Multiply this population by 2.73, which is the average number of members per household in the U.S.

Option 2 - Using SMRB collected demographics on the buyer's household size, multiply the household size by the number of buyers and then add the results to estimate the total passively exposed population. For example, to generate a conservative estimate:

1 person household = Number Buyers x 1 = A
2 person household = Number Buyers x 2 = B
3 or 4 person household = Number Buyers x 4 = C
5 or more person household = Number Buyers x 6 = D

A + B + C + D = total passively exposed population

5.3.2 Enumeration of Exposed Populations via Production and Sales Data

Users of consumer products can be enumerated by applying a number of assumptions and estimation techniques to economic data such as chemical production volume, Census of Manufactures output, and retail sales information. To enumerate the users of a consumer product, the investigator must estimate the number of units of a product bought by consumers, then apply data on usage patterns to determine the average number of consumers. The result of this calculation will be an estimate, but a fairly valid one; the components of the calculation are reliably predicted. An example of the method (Method 5-3) is presented in Appendix A-4.

The parameters specific to this calculation are the number of units of the product manufactured or sold annually and the annual usage patterns. The first, the number of units, can be derived in the manner described in problem 2 in Appendix A-4 (by assuming an average mass per unit) or by consulting published data. The Census of Manufactures (Bureau of the Census 1980) lists production of very specific products (by seven digit SIC code) in units such as pounds, kilograms, cases, etc. The assessor must assume that production equals sales to consumers. Other data bases containing this type of information and specific information on retail sales are listed in the consumer exposure assessment methods report (Volume 7). Use patterns can be either estimated on a product-specific basis or derived from the use information provided by SMRB data, as detailed in the previous Subsection (5.3.1).

It should be noted that this method of population estimation assumes that users are brand-loyal; i.e., for any product, a consumer either always or never uses a brand with the chemical. The result of this assumption is that some consumer populations may be underestimated; some individual exposures may likewise be overestimated. The calculated individual exposure resulting from the use of the product will be higher than if the consumer used various brands or formulations, some of which contained the chemical substance and some of which did not. The information needed to resolve this problem is not available at this time.

5.3.3 Enumeration of Exposed Populations via Chemical-Specific Information

Populations exposed to chemical substances in consumer products can be enumerated through the use of various sources of chemical-specific information. The approach is not as methodical as that applied to the use of market research data or economic (production and sales) data; rather, it entails researching information sources each time a chemical is assessed. The various types of information resources and the advantages and limitations of each are discussed below.

Method 5-3. Enumeration of Populations Exposed to Chemicals in Consumer Products Via the Use of Economic Data

Step 1 Determine the number of units of the product sold or produced annually.

Option 1 - consult the Census of Manufactures (Bureau of the Census 1980) to obtain production in unit quantities.

Option 2 - estimate the number of units produced by dividing the amount of the chemical destined for that use by the formulation percent and the total mass of product per unit.

Option 3 - consult Volume 7 for alternative sources of data (sales information, computerized data).

Step 2 Determine use patterns for the product. The SMRB presentation of heavy-medium-light use, discussed in Section 5.3.1, provides data for most products. Heavy use may, for example, be defined as 5 or more cans per week; medium use, 3 or 4 cans, and light use, 2 or fewer cans per week.

Step 3 Calculate the exposed population by dividing the production volume in units (from Step 1) by the units used per person per year (from Step 2).

(1) Direct contact with associations. Associations are able to provide many types of consumer-related information. Many associations are headquartered in the Washington, D.C., area and can be found in the telephone directory. The most comprehensive list of associations, however, is in the Encyclopedia of Associations (Gale Research 1980). Although associations can often provide the most accurate and precise estimates of consumer populations, acquiring the data may be time consuming and may therefore limit the usefulness of this method to detailed assessments.

When an association is consulted for population estimates, the contact should be informed of the reason for the request so that he can provide the best possible data. The representativeness of the data should be questioned; for example, a hobbyist association may be able to provide a membership number and also be able to say that the membership represents 75 percent of the total hobbyists.

Although there are some limitations to this approach, it has been used successfully in exposure assessments for many existing chemicals. When sufficient time and use information is available, PMN substances can be investigated in the same manner. Care must be taken to avoid disclosure of confidential business information (CBI) provided by PMN submitters.

(2) Government agencies. The Environmental Protection Agency (EPA), the Consumer Product Safety Commission (CPSC), and the Bureau of the Census can provide pertinent consumer information. The information is available through direct contact with experts in the agencies and the reports they publish.

CPSC has collected a great deal of information on recognized hazards such as asbestos. Information provided by CPSC may aid exposure assessments of consumer products containing existing chemicals and new substances intended as substitutes for recognized hazards. The CPSC, however, limits its data collection efforts largely to substances that have proved harmful. Unless a new chemical is similar in properties and is analogous in use to an existing chemical, CPSC's data are of little aid in investigating new chemicals.

The many publications of the Bureau of the Census may contain useful information. For example, those exposed to formaldehyde by residing in mobile homes were quantified (Versar 1982) by consulting the Annual Housing Survey (Bureau of the Census 1981). The Statistical Abstract of the United States (Bureau of the Census 1982) may also provide activity-related data that are useful in enumerating consumer populations.

Studies of existing chemicals are often conducted by more than one EPA Office and by many contractors. An exposure assessment of such a substance will benefit from a review of the published literature (available through the National Technical Information Service). The authors or sponsors of these reports may provide additional data if contacted directly.

Some consumer products are so widely used that one can safely assume the entire population of the U.S. may be exposed. For instance, all persons contact plastics and fabrics; common additives to them may cause nationwide exposure. The most recent data available from the Bureau of the Census should be used to enumerate the exposed population. Currently, a total of 226.5 million persons are reported to reside in the U.S. (Bureau of the Census 1982).

5.3.4 Enumeration of Consumers Performing Amateur or Hobbyist Activities

Consumers may be exposed to chemical substances in products designed mainly for use by professionals. Persons who do their own automobile maintenance and repair, house painting, lawn care, carpentry and remodeling, or photographic film development may be exposed to a chemical substance in a product that might be overlooked in a consumer exposure assessment. Enumeration of the exposed population may be keyed to the number of people engaged in these activities when other enumeration procedures, as previously discussed, are not possible. This method of enumeration, however, overestimates the exposed population because it assumes that all people who engage in a particular activity use the product or products containing the chemical substance.

All of the estimates assume that there is one amateur per household. The estimates presented below and summarized in Table 25 rely on the Bureau of Census (1982) estimate of 77,330,000 households in the U.S. and the following additional data.

(1) Automobile work. The U.S. Department of Energy (1980) estimates that 85 percent (65,700,000) of all households have at least one motor vehicle and that 55 percent of those households change their own oil. Thus, 36,100,000 households are estimated to have at least one person who changes his own oil.

(2) Painting. SMRB (1978) reports that 17.5 percent of U.S. households purchased exterior paint and 25.7 percent purchased interior paint during a one-year period. If it is assumed that the persons purchasing paint intended to use it themselves (rather than providing it to a hired professional painter), the potentially exposed population can be estimated. If only one member of each household uses paint, then 13,533,000 persons are actively exposed to exterior paint and 19,874,000 are exposed to interior paint. The members of each household would experience passive exposure to paint components, probably only in

interior paint. With an average of 2.78 persons per household, the passively exposed population is 55,250,000 persons.

(3) Lawn and garden care. The number of people who mow their own lawn provides a fair estimate of people who use fertilizers, pesticides, and other lawn and garden products. SMRB (1978) estimates that 37 percent of households own a lawn mower. Assuming that one person from each household is responsible for lawn care, an estimate of 28,612,000 people tend their own lawns.

(4) Carpentry. A rough estimate of the number of people who engage in carpentry can be made based on ownership of electric saws. Anyone seriously involved in carpentry and, therefore, potentially exposed to chemical substances in carpentry related products, would own this tool. SMRB (1978) estimates that 23 percent of all households own an electric saw. Therefore, at least 17,786,000 households include amateur carpenters.

(5) Remodeling. The number of people potentially exposed to chemical substances as a result of household remodeling activities can also be estimated from SMRB data. SMRB (1978) estimates that 1,132,000 basements, 2,313,000 kitchens, 2,572,000 bathrooms, and 3,898,000 other rooms were remodeled in 1976-77 by a household member. Based on the number of households in 1977 as estimated by SMRB, 74,019,000, the following percentages are derived; 1.5 percent of households had basements remodeled, 3.1 percent of households had kitchens remodeled, 3.5 percent of households had bathrooms remodeled, and 5.3 percent of households had other rooms (e.g., living rooms, bedrooms) remodeled by a household member. Assuming these data are representative of current remodeling activities, the percentages can be applied to the current number of U.S. households to calculate populations. The results are presented in Table 25.

(6) Photography. An estimated two to three million people develop their own film (Wolfram Report 1979). This would be 2.6 to 3.9 percent of the U.S. households, assuming that there is only one photographer per household.

5.4 Characterization of Exposed Populations

Exposed populations are often characterized by age and sex, since physiological parameters affecting exposure or risk are often age- or sex-dependent. Characterization of consumer populations is especially important, since many products are designed for or used by specific subpopulations.

Table 25. Summary of the Number of Households That Can Be Considered To Have at Least One Amateur or Hobbyist with Respect to a Specific Activity.

Activity	Number of households[1]	Percent of all households
Crankcase oil and filter change	36,100,000	47
Lawn and garden maintenance	28,612,000	37
Painting (exterior of house)	13,533,000	17.5
Painting (interior of house)	19,874,000	25.7
Carpentry	17,786,000	23
Remodeling		
Basement	1,160,000	1.5
Kitchen	2,397,000	3.1
Bathroom	2,707,000	3.5
Other	4,098,000	5.3
Photography	2,500,000	3

[1] Based on 77,330,000 households in the U.S. (Bureau of the Census 1982).

As was discussed in Subsection 5.3.1, the SMRB data are presented by detailed demographic characteristics. The populations reported as buyers/users of each product, assumed to be the actively exposed populations, are defined by sex and then stratified by age (see Tables 22 to 24). The characteristics of adults actively exposed to consumer products are therefore readily available. Less easily characterized are persons under the age of 18 and passively exposed populations. The SMRB data report only the relative frequency of the presence of children in the age groups of 0 to 2, 2 to 5, 6 to 11, and 12 to 17 years of age in the households with active users.

The only data available for characterizing the consumer population under 18 by age and sex are the national distributions presented in Section 2.4 of this volume (Table 12). Should such a characterization of the population be necessary, the assessor must assume that the affected group can be described by those data or a discrete subset thereof (i.e., males or females or some defined age group).

As described in Subsection 5.3.1, persons passively exposed in a user's household can be enumerated by use of the relative frequency of household sizes. However, no characteristics of the household members are available; generic data must be used to characterize that population. If it is assumed that the total population of persons living in households with users of the product represent a cross-section of the total U.S. population, the data (Table 12) in Section 2.4 of this volume can be used to describe the age and sex characteristics of the group.

Method 5-4 summarizes the steps to be performed in the characterization of populations exposed to chemical substances in consumer products.

Method 5-4. Characterization of Populations Exposed to Chemical Substances in Consumer Products

Step 1 If the consumer population was enumerated by the use of SMRB data, use the demographic characteristics reported for buyers/users to characterize the actively exposed population by age and sex.

Populations enumerated by other methods can also be characterized by consulting the SMRB report for the product(s) most similar to that being assessed.

Step 2 Consult Section 2.4 (Table 12) of this volume to derive generic age and sex characterization for:

- Consumer populations under the age of 18
- Passively exposed household members
- The entire population of the U.S.

5.5 References

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6. POPULATIONS EXPOSED TO CHEMICAL SUBSTANCES VIA THE INGESTION OF DRINKING WATER

6.1 Introduction

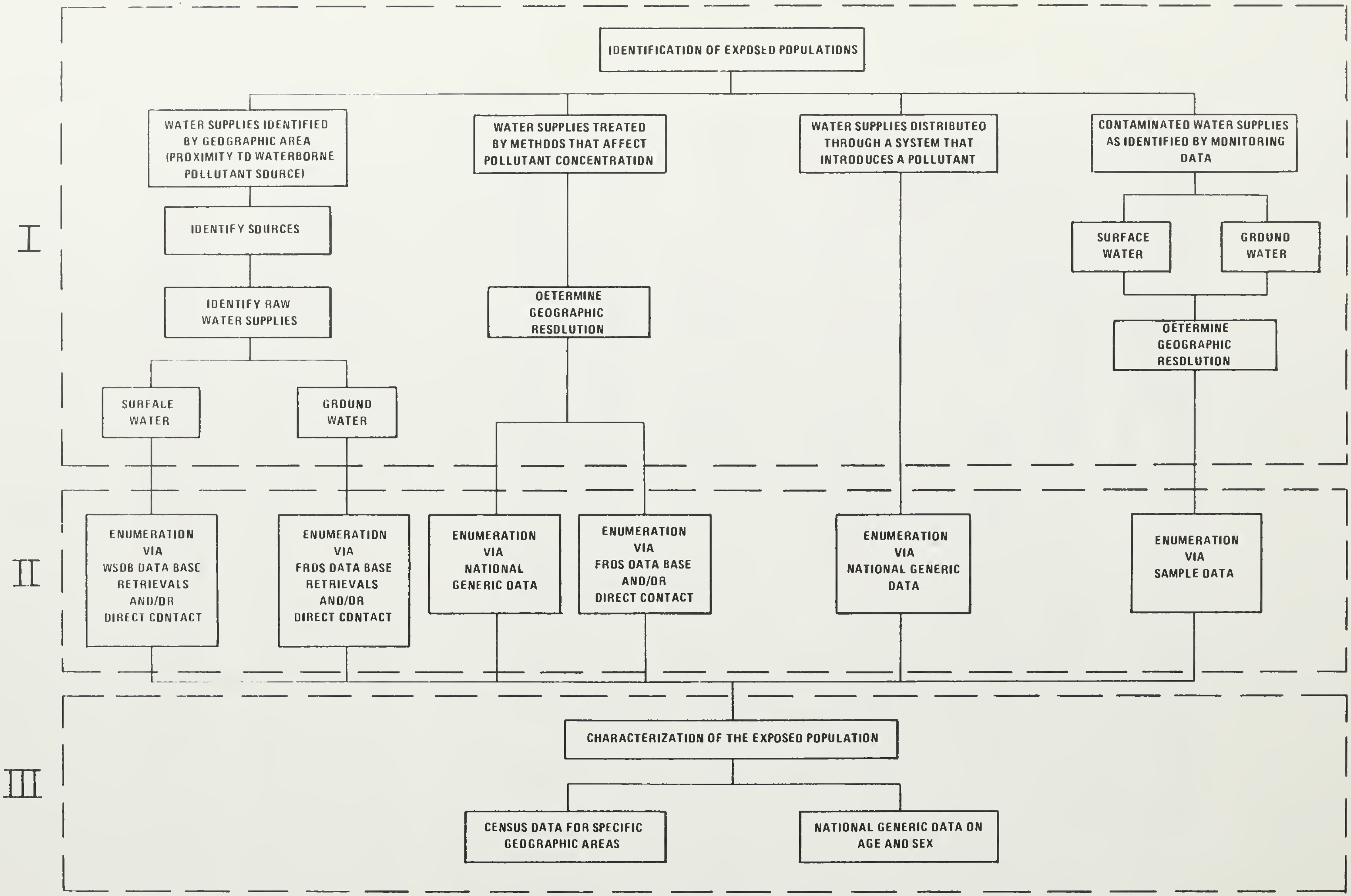
This section presents methods for the enumeration and characterization of populations exposed to chemical substances via the ingestion of drinking water. The methods described are applicable to publicly and privately supplied drinking water that may contain chemical substances as a result of (1) industrial, commercial, and household effluents to surface and ground water, (2) runoff or seepage from waste disposal sites, (3) non-point source runoff or seepage from agricultural and nonagricultural land uses, (4) drinking water treatment processes, (5) drinking water distribution systems, and (6) pollution of unknown origin. The methods are based on exposure as a result of the voluntary ingestion of drinking water; as such, the methods do not consider involuntary ingestion (e.g., swallowing of water during swimming) or dermal and inhalation exposure to chemical substances in drinking water.

Figure 21 is a flow diagram of the three-stage method framework for enumerating and characterizing populations exposed to chemical substances via the ingestion of drinking water. The following paragraphs briefly describe each of the stages; detailed information is provided in subsequent sections.

The first stage, identification of exposed populations, is accomplished by examining the sources of the chemical substance. Detailed information on procedures to complete a drinking water exposure assessment, which include identification of the exposed population, is included in Volume 5 of this series, in "Methods for Assessing Exposure to Chemical Substances in Drinking Water." Subsection 6.2, therefore, only briefly describes the procedures for identifying the exposed population.

Enumeration of the exposed population is discussed in Subsection 6.3. This stage involves the use of various computerized data bases that contain information on drinking water such as the sources of the raw water supply, intake locations, treatment methods, and populations served. Enumeration also involves the use of generic data on populations served when detailed geographic resolution is not required or when the financial or manpower constraints of the exposure assessment effort do not permit the development of detailed information.

The final subsection (6.4) describes the procedures for characterizing the enumerated population according to age and sex. Data sources are presented which will provide age and sex characteristics of


I
II
III
IDENTIFICATION OF EXPOSED POPULATIONS
WATER SUPPLIES IDENTIFIED BY GEOGRAPHIC AREA (PROXIMITY TO WATERBORNE POLLUTANT SOURCE)
WATER SUPPLIES TREATED BY METHODS THAT AFFECT POLLUTANT CONCENTRATION
WATER SUPPLIES DISTRIBUTED THROUGH A SYSTEM THAT INTRODUCES A POLLUTANT
CONTAMINATED WATER SUPPLIES AS IDENTIFIED BY MONITORING DATA
IDENTIFY SOURCES
IDENTIFY RAW WATER SUPPLIES
SURFACE WATER
GROUND WATER
DETERMINE GEOGRAPHIC RESOLUTION
SURFACE WATER
GROUND WATER
DETERMINE GEOGRAPHIC RESOLUTION
ENUMERATION VIA WSDB DATA BASE RETRIEVALS AND/OR DIRECT CONTACT
ENUMERATION VIA FRDS DATA BASE RETRIEVALS AND/OR DIRECT CONTACT
ENUMERATION VIA NATIONAL GENERIC DATA
ENUMERATION VIA FRDS DATA BASE AND/OR DIRECT CONTACT
ENUMERATION VIA NATIONAL GENERIC DATA
ENUMERATION VIA SAMPLE DATA
CHARACTERIZATION OF THE EXPOSED POPULATION
CENSUS DATA FOR SPECIFIC GEOGRAPHIC AREAS
NATIONAL GENERIC DATA ON AGE AND SEX

WSBD - WATER SUPPLY DATA BASE
FRDS - FEDERAL REPORTING DATA SYSTEM

Figure 21. Three-stage Framework for Enumerating and Characterizing Populations Exposed to Chemical Substances via the Ingestion of Drinking Water

populations where geographic detail is required or generic age and sex characteristics for situations where specific detail is not required.

Examples of the use of the methods in this section are presented in Appendix A-5 of this report.

6.2 Identification of Exposed Populations

Exposed populations can be identified either through knowledge of the sources of chemical contamination or by examination of monitoring data. The former is a "materials balance" approach and comprises three types of sources:

1. Sources that can be geographically defined (e.g., industrial effluents and non-point sources of water pollution).

2. Sources related to the treatment processes used in production of potable water (e.g., use of chemicals as coagulant aids).

3. Sources within the distribution system (e.g., dissolution of solvents from glued pipe joints).

Monitoring data may identify water sources with contamination of known or unknown origin.

Comprehensive identification must consider all three source types as well as available monitoring data. Identification may be keyed to the geographic location of the water supply, treatment methods, distribution system type, or any combination of the three. The procedure for identification is presented as Method 6-1.

It is readily apparent that only Step 1 of Method 6-1 provides positive identification of exposed populations; the materials balance approach outlined in Steps 2 and 3 identifies those that are potentially exposed. The drinking water exposure assessment methods report (Volume 5) presents detailed methods for identifying exposed populations.

The populations identified in this stage must subsequently be enumerated. The following subsection discusses the methods for enumerating populations defined by the three types of sources and identified through monitoring data.

6.3 Methods for the Enumeration of Exposed Populations

This section discusses the recommended procedures and data sources for enumerating populations exposed to chemical substances via the ingestion of drinking water. The section is divided into four subsections based on the categories for identifying the exposed

Method 6-1. General Procedure for Identifying Populations Exposed to Chemical Substances in Drinking Water

Step 1 Obtain all available monitoring data for the substance being assessed. Monitoring data for finished water provides positive identification of an exposure source; however, it may not identify what the source is. The population served by the utility surveyed is an exposed population.

Step 2 Examine the environmental releases of the substance in the ambient environment. Knowledge of these releases, coupled with knowledge of the environmental fate of the substance in the aquatic environment, leads to identification of contaminated aquifers and surface waters. The persons drinking these waters are potentially exposed.

Step 3 Examine the uses of the substance. If it is used in the drinking water treatment or distribution systems, the populations served by those systems may be exposed.

(NOTE: Detailed information on identifying sources of chemical contamination and exposed populations is provided in Volume 5 of this exposure assessment methods report series.)

populations. Subsection 6.3.1 presents the procedures and data sources for enumerating exposed populations that are geographically defined by the sources of the chemical substance of interest; the procedures in Subsection 6.3.2 enumerate populations exposed to chemical substances as a result of drinking water treatment processes; the procedures in Subsection 6.3.3 enumerate populations exposed to chemical substances from the materials (e.g., pipes) used to distribute drinking water; and the procedures in Subsection 6.3.4 enumerate populations exposed to chemical substances that have been identified from water quality data collected during drinking water monitoring. The investigator's choice of an appropriate method should be based on how the exposed population has been identified.

6.3.1 Enumeration of Populations in Specific Geographic Areas

This section presents methods for enumerating populations in specific geographic areas where sources of the chemical substance of interest are located. These sources may include industrial, commercial, or household effluents, Publicly Owned Treatment Works (POTWs), waste disposal sites (e.g., landfills, wastewater lagoons), and transportation related spills. The individual volumes of this series discuss the data sources and procedures for identifying the sources of a chemical substance. Methods to link geographically-defined point sources with nearby drinking water intakes are discussed in the drinking water exposure assessment methods report (Volume 5). Identification of the sources of the chemical substance in turn permits the identification of the affected raw drinking water supplies. Identification of the raw water supplies, therefore, is the first step required. The type of raw water supply used, either surface water or ground water, determines the data bases that should be used in the population enumeration effort.

(1) Surface water. The principal data source for identifying both public and private drinking water utility companies that use surface water as their raw water supply is the Water Supply Data Base (WSDB). WSDB is a computerized data base maintained by the EPA Monitoring and Data Support Division, Water Quality Analysis Branch. It contains information on the location of surface water utilities; the locations of the utilities' treatment plants, intakes, and sources of raw water; the populations served; and the average and maximum daily production. A complete description of WSDB is available in Water Supply Data Base: Inventory of Surface Water Supplies and Addendum on a Groundwater Data Base Structure (Versar 1981).

The most useful application of WSDB is the integration of its data with data on sources and concentrations of chemical substances contained in other data files maintained by EPA-MDSD, such as the Industrial Facility Discharge (IFD) File and the STORET Water Quality Data Base. The data in each of these files can be accessed via another data base known as the REACH File. A complete description of the REACH File is not within the scope of this report; essentially, however, the REACH File is a data source for information on surface water, rivers, streams, lakes and reservoir segments that are coded within the U.S. Geological Survey's Hydrologic Unit Cataloging System. The drinking water intake locations in WSDB, the industrial discharge locations in IFD, and the locations of water quality monitoring stations in STORET are similarly coded with a REACH number. The REACH number, therefore, hydrologically links these files together. EPA-MDSD has developed several software packages to access the data contained in the various files via the use of the REACH number. Population data contained in WSDB may be obtained in this integrated approach. Method 6-2 lists the procedural steps of the integrated approach to obtaining information on sources, affected surface water supplies, and populations served. The drinking water exposure assessment methods report (Volume 5) provides a much more detailed description of WSDB and the other hydrologically linked data bases. (Note: Requests for data base retrieval should be directed to Mr. Phil Taylor, USEPA, Monitoring and Data Support Division, Water Quality Analysis Branch.)

The investigator will now have identified sources, raw water supplies, drinking water utilities, and populations served in one integrated process. EPA-MDSD is further expanding the usefulness of the integrated approach by assigning river mile indexes to all discharge points in IFD and intake points in WSDB. This will facilitate determination of the distances between these points. Distance calculations can then be used to model in-stream water quality dilution and the resultant concentration at drinking water supply intake points. Details on retrieval methods, keywords, and other integrated approaches are available in General Information on IFD, Drinking Water Supplies, Stream Gages, Reach, and Fishkill Files and Retrieval Procedures for Hydrologically Linked Data Files (USEPA 1981a).

The enumeration of populations exposed to chemical substances via surface water supplies contaminated by other sources (e.g., runoff from waste disposal sites, non-point sources) is also straightforward. The recommended approach is presented as Option 2 in Method 6-2.

The investigator should be aware of two limitations in WSDB, and they should be noted in the exposure assessment report. First, the intake location coordinates for drinking water utilities that serve populations less than 25,000 are only approximate locations (generally within ±10 minutes of latitude and longitude). Location coordinates for utilities serving more than 25,000 people are extremely accurate because they were developed from USGS 7.5-minute topographic maps. The second limitation is that the population data were collected between 1965 and 1975 and may not reflect current populations. If the data set of identified utilities is limited, the investigator should contact the drinking water utility supervisor and directly request up-to-date data on populations served by

Method 6-2. Enumeration of Populations Exposed to Chemical Substances in Surface Sources of Drinking Water Using the REACH File

Option #1 - To be used for surface sources contaminated by industrial and POTW effluents. For detailed information on the following steps, see Volume 5 of this methods series or USEPA (1981a).

Step 1 Identify applicable SIC codes for the chemical substance of interest (see Volume 2, Methods for Assessing Exposure to Chemical Substances in the Ambient Environment).

Step 2 Request retrieval of IFD data for facilities within SIC category (requests should be directed to Mr. Phil Taylor, USEPA, Monitoring and Data Support Division, Water Quality Analysis Branch, Washington, DC).

Step 3 Identify receiving water bodies by REACH number and USGS cataloging unit. (Note: The REACH number actually consists of 11 digits and includes the 8-digit USGS cataloging unit and the 3-digit EPA segment number. The segment number is frequently referred to as the REACH number. Retrievals limited to the entire 11-digit REACH number will identify water supply intakes and industrial discharges only on that particular segment. If a retrieval is made according to the USGS cataloging unit only, it will identify all points of interest in the USGS surface water drainage basin.)

Step 4 Request a hydrologic tree retrieval (HYDRO) from EPA-MDSD for each REACH number or cataloging unit identified. Include a request for populations served in the data tabulation. HYDRO will list in a tree diagram industrial discharge pipes, water supply monitoring stations, and water supply intake points according to hydrologic order. "Hydrologic ordering" provides stations on the most downstream reach first, and proceeds upstream, reach by reach.

Option #2 - To be used for surface sources contaminated by non-industrial effluents (e.g., chemical spills, non-point sources, waste disposal site runoff).

Step 1 Identify contaminated raw water supplies by USGS Hydrologic Units (8-digit number) using USGS State Hydrologic Unit Maps. Segment numbers, if desired, can be obtained from Mr. Robert Horn, EPA-MDSD, Monitoring Branch.

Step 2 Request WSDB retrievals from EPA-MDSD according to USGS hydrologic units. Include population served and intake name and location as parameters in data tabulation request. Check WSDB retrieval to determine whether listed utilities are withdrawing water directly from or downstream of the water body of concern.

the utilities' distribution system. (Note: Drinking water utilities will frequently perform a residential meter count rather than an actual head count of residential customers. If data are provided in this format, the investigator can assume 2.73 persons/meter based on Census data for the number of persons per household (Bureau of Census 1982a) to enumerate the total population.)

The WSDB is recommended as the primary data source for enumerating populations exposed to chemical substances via the ingestion of surface supplied drinking water. This is principally due to the inclusion of the REACH number in the data base structure. That number facilitates an integrated process of identifying sources (i.e., industrial and POTW dischargers) of chemical substances and enumerating exposed populations as previously described. There is another data base, however, that includes surface water populations served and intake locations. This data base, maintained by the EPA Office of Drinking Water, is known as the Federal Reporting Data System (FRDS). FRDS, discussed in the subsequent section on ground water, can be used as a source of information supplementary to that contained in WSDB. It can also be used to check the accuracy of the WSDB-listed population data. FRDS population data are updated annually by each primary agency (i.e., state or EPA region). As such, the population data is more accurate than the data stored in the WSDB. Cross-referencing of the two data bases is straightforward because WSDB listings include the FRDS utility number in the data structure. FRDS geographic restricted retrievals can be made by state, county (i.e., according to FIPS code), SMSA and USGS hydrologic units.* FRDS, however, does not include EPA developed stream segment numbers for intake locations; therefore, integrated data retrievals with other STORET and EPA-MDSD-maintained data files are not possible. The recommended method for obtaining and using FRDS data is presented in Method 6-3.

(2) Ground water. The principal data source for identifying either public or private drinking water utilities that use ground water is the previously mentioned Federal Reporting Data System (FRDS).

FRDS is an information management system used by both EPA headquarters and regional personnel to monitor program performance in each state. It contains inventory data as well as the compliance status of each public water supply. Separate data bases are maintained for each

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*A.W. Marks, EPA-Office of Drinking Water, Washington, DC: personal communication with M. Callahan, EPA-Office of Toxic Substances; memorandum dated August 2, 1983.

Method 6-3. Enumeration of Populations Exposed to Chemical Substances in Surface Sources of Drinking Water Using the FRDS Data Base

Step 1 Request FRDS retrieval according to geographic area of interest (e.g., by state and/or county according to FIPS code, by SMSA according to SMSA code, or according to USGS cataloging unit).

Note: FRDS retrieval requests should be directed to:

Mr. Avrum Marks
Manager Computer Systems Staff
EPA Office of Drinking Water
Washington, DC 20460

Step 2 Scan retrieval for utilities listed that obtain raw water supplies from the water bodies of interest.

Step 3 Check for utilities that purchase finished drinking water from another utility. Under "source type," these utilities will be listed with the letter P. When totaling populations served, the investigator should not count population data for these utilities since these are already contained in the population served data for the utility that is processing the raw water. This avoids "double counting" the exposed population.

Step 4 Total the data on population served to enmumerate the total population exposed to the chemical substance of interest.

fiscal year after 1978 as well as the current year. FRDS became operational during January of 1979. As of April 15, 1980, information from all 57 states and territories, as well as information on Indian reservations within four EPA regions, had been received and processed.

Four types of data are collected by FRDS, based on regulatory reporting requirements (Marks 1980):

1. Inventory. This includes public water supply (PWS) capacity, source information, monitoring requirements, and facility name and address. Figure 22 is a sample report containing the types of information available for each PWS. However, since many of the data elements are not required for federal reporting, all of this information may not be available for each PWS.

2. Violation. This includes data pertaining to noncompliance with EPA or state standards by a specific water supply.

3. Variance and exemption. This includes data pertaining to authorized exceptions to the standards which are granted to a specific water supply.

4. Enforcement action. This includes information pertaining to actions taken against a public water supply.

In addition, summary statistics for each state are generated and maintained within the FRDS data base. The data types of greatest relevance are the inventory information and the summary statistics. Besides the ad hoc capabilities of the system, 11 standard reports have been generated. These are summarized in Table 26. The most useful are marked with an asterisk; they include reports listing data on populations served (number of meters), source location, treatment types (where available), and percentage breakdowns of data for individual states.

The procedure for enumerating populations exposed via ground water is to define the area of concern as determined by the sources of the chemical substance of interest (e.g., landfill leachate to ground water in a specific county or state). This step will be completed as part of the overall exposure assessment process. Detailed information on procedures for completing this step are presented in the drinking water exposure assessment methods report (Volume 5). The procedure is summarized in steps in Method 6-4.

The output of the procedure will be a list of all facilities in the geographic region selected (which may or may not be tapping the aquifer of interest), together with the population served and treatments used by each facility. The degree to which this information is complete depends on the thoroughness of the input from the particular state.

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                                              MODEL STATE INFORMATION SYSTEM
PWSI060 01.05                              PUBLIC WATER SYSTEM INVENTORY SUBSYSTEM

DATE 03/30/79                                          COMPREHENSIVE REPORT                                                          PAGE   177
                                                     SELECTION EXTRACT FILE
PWS-ID: 4100693  NAME: REDMOND WATER DEPT.                     PHONE: (503) 548-2148        INDIAN RESERVATION CODE:
        PLANT ADDRESS: 455 S. 7TH ST.                          PLANT AREA LOCATION:         COMPLIANCE CYCLE: 01
                       REDMOND                    OR 97756           CITY:                  POSTAL CODE: OR
         MAILING NAME: REDMOND WATER DEPT                            COUNTY: 017            PLANT TYPE: C     OWNER TYPE: M
      MAILING ADDRESS: 455 S. 7TH ST.
                       REDMOND                    OR 97756           REGION:             DISTRICT:        PLANT BEGIN DATE: 06/77
PLANT     RESIDENTIAL:1  COMPANY TOWN: 0  RECREATION  : 0  MOBILE HOMES  : 0  INSTITUTION  : 0  SCHOOL : 0 OTHER AREA:  0
SERVICE    MOTEL     :0  RESTAURANT  : 0  SERV STATION: 0  CAMPGROUND    : 0  PICNIC AREA  : 0  LODGE  : 0
  AREA:    MARINA    :0  SKI RESORT  : 0  BATHING     : 0  VISITOR CENTER: 0  HWY REST AREA: 0  AIRPORT: 0

                                                                                         CONSECUTIVE INDICATOR: 0
  POPULATION SERVED: 000005325   NUMBER OF SERVICES: 0001775   NUMBER OF METERS: 0000660   NUMBER OF CONSECUTIVE PWS:
  DESIGN CAPACITY:  0002700000   EMERGENCY POWER: 0002000000   STORAGE CAPACITY:0002000000 MAXIMUM PRODUCTION: 0007128000
  INTERSTATE CARRIER:     N      AVERAGE PRODUCTION:0002600000 LAST SURVEY DATE: 00/00/00  LAST UPDATE DATE:    04/17/78
  DEACTIVATION REASON:           DEACTIVATION DATE: 00/00/00   MANUAL FILE:                REGULATE BY: B     ACTIVITY CODE: A

STATE DISCRETIONARY DATA:
  BACTERIOLOGICAL FLG: L     MINIMUM NUMBER DAILY CHECKS:        NON-COMMUNITY SAMPLING FREQ: 000            SEASON
  MONTHLY MONITORING:  N     SAMPLES PER QUARTER: 000            MCL HALT CHECK SAMPLE: 0          START: 00/00   END: 00/00
  CHLORINE : 00              TURBIDITY FLAG: L                   TURBIDITY UNITS: 0.0

FOLLOW-UP:            CONTAMINANT ID:
                      SAMPLING FREQ :
  ORGANIC CHEMICALS:                 ORGANIC                      INORGANIC CHEMICALS:
                      BEGIN PERIOD: 00/00 END PERIOD: 00/00                        AIR TEMPERATURE: 00.0     NITRATE FREQUENCY: 0000
RADIOACTIVE: FLAG: 4  MONITORING: 3  BETA FREQUENCY MONTHS: 00  MONITOR GROSS ALPHA: 00   MONITOR RADIUM MONTHS: 00
          GROUND WATER MONITOR: 0  NO SAMPLES PER YEAR: 0     NUCLEAR FACILITY: N      NUCLEAR FACILITY TYPES:

        FACILITY CONTAMINANT ID:
        SAMPLING FREQUENCY:
OPERATING REPORT:   REPORT REQUIRED: N  LAST REPORT DATE: 00/00   ENGLISH/METRIC SYSTEM: E
  STATE RESERVED:   41699201500000

LAB DATA:                                          VARIANCE OR EXEMPTION:
        LAB ID:                                         CONTAMINANT ID   :
   CAPTIVE FLAG:                                        MODIFIED MCL     :
PLANT SOURCES NUMBER: 03                                ALT MONITOR FREQ :
SOURCE INFORMATION:                                                                                             TREATMENTS
                                                                                                    A P C S F C S T I A F D O   R
                                                                                                    E R O S I O O A R M L I T   E
                                                                                                    R E A D L R F S O M U S H   S
                    SOURCE     NUMBER                     BASIN                            SELLER   A C G I T R T T N O O I E   E
  SOURCE NAME        CODE     OF WELLS    AVAILABILITY    NUMBER    LATITUDE    LONGITUDE    ID     T H L M R O E E R N R N R   R
 DESCHUTES RIVER      S                                            044.15.51   121.17.54            0 1 1 0 1 0 0 1 0 0 0 0
 DESCHUTES R. BY      S                                            044.15.00   121.15.00            0 1 1 0 1 0 0 1 0 0 0 0
 WELL PUMP #13        G                                            044.16.42   121.17.20            0 1 0 0 0 0 0 0 0 0 0 0
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Figure 22. Example Printout of the Model State Information System-Public Water Supply Inventory for Redmond City, Oregon

Table 26. Federal Reporting Data System (FRDS)
Description of 11 Standard Reports

Report Title	Description
*1. Public Water Systems - Comprehensive Listing	Lists all PWSs meeting the selection parameters, one per page, showing all PWS inventory data.
*2. Public Water Systems - Production and Capacity Data	Details production, capacities, meters, and services data for each PWS meeting the user's selection criteria.
*3. Public Water Systems - Service Area and Source Data	Lists service area location and characteristics and water source information, including treatments, for each PWS satisfying the user's selection criteria.
4. Public Water Systems - State Discretionary Data	Details all state discretionary data and variances and exemptions for each PWS satisfying the user's selection criteria.
*5. Number and Percentage of Facilities and Populations Served by Type of Water Supply Source	Shows this information by population category and by state.
6. Enforcement Actions Summary by Population	Shows number of enforcement actions occurring by state, population category, and type.
7. Enforcement Actions Summary by Type and Source	Shows number of enforcement actions occurring by state, type of action, and type of water source.
8. Violations Summary by Population	Shows number of violations occurring by state, population category, and type.
9. Violations Summary by Type and Source	Shows number of violations occurring by state, contaminant, type of violation, and type of water source.
10. Variances and Exemptions Summary by Population	Shows number of variances and exemptions by state, population category, and type.
11. Variances and Exemptions Summary by Type and Source	Shows number of variances and exemptions by state, contaminant, type, and type of water source.

* Indicates report useful for population enumeration effort.

Source: Marks 1980. As updated via personal communication by A.W. Marks, EPA-Office of Drinking Water, to M. Callahan, EPA-Office of Toxic Substances; memorandum dated August 2, 1983.

Method 6-4. Enumeration of Populations Exposed to Chemical Substances in Ground Sources of Drinking Water

Step 1 Request a FRDS retrieval for the subject county and all surrounding counties: or by SMSA. This should be a "Comprehensive Listing" of all PWS using ground water in the subject counties or SMSA. Since the specific aquifer used as the source is almost never identified, it will have to be assumed that all local ground water facilities are potentially tapping the subject aquifer. The FRDS printout will supply data on populations served and treatment types used. When populations are totaled, the population data included in utility listings that purchase finished water (Code P under source type) should not be included. This avoids counting populations twice.

Step 2 FRDS does not include private wells. If necessary, this number can be deduced by conducting both surface water and ground water retrievals for the subject area, and subtracting population figures from the total population of the region (available from the Bureau of the Census (1982b)).

Although the WSDB is not, at this time, a useful data source for enumerating populations exposed via ground water, EPA-MDSD plans to expand the WSDB ground water coverage. The WSDB structure has been recently expanded to facilitate the storing of ground water utility information (Versar 1981). Included in the ground water utility information is the capability for recording the name and USGS-developed code for the aquifer from which the water is obtained. Presently, only the data for the 100 largest cities in the U.S., as identified by USGS in 1962 (Durfor and Becker 1964), have been added to WSDB. These data were updated in a telephone survey in 1981 (Versar 1981) before being added to the data base. The updating of WSDB with data on all ground water utilities in the U.S. is tentatively planned by EPA-MDSD pending determination of future funding priorities.

6.3.2 Enumeration of Populations Exposed via Treatment Methods

The screening of a chemical substance's sources may identify a drinking water treatment process, or lack thereof, that could result in human exposure. For example, the addition of a polyelectrolyte (e.g., polyacrylamide) to coagulate suspended sediments in raw water may add a residual contaminant (e.g., acrylamide monomer) to the finished drinking water. Similarly, the absence of activated carbon filtration treatment of raw water contaminated with organic chemicals may result in the production of finished drinking water containing organic chemicals. Exposed populations may, therefore, occasionally be identified by a treatment process or combination of processes. The primary data source for the enumeration of populations exposed via treatment processes is the FRDS Data Base discussed in Subsection 6.3.1(2).

FRDS contains figures for the number of people served for each listed public water supply system; in many cases treatment methods are also listed. Treatment information is not required by EPA but is often supplied by states. The population served by treatment type, therefore, is slightly inaccurate. It will, however, provide an estimate of the order of magnitude of the population size.*

The EPA Office of Drinking Water, which maintains FRDS, has put together several summary reports that relate populations, locations, and water source (ground vs. surface) with treatment processes (Marks 1980). These reports are listed in Table 26, Subsection 6.3.1(2). These reports are valuable as quick reference documents to enumerate populations when general geographic area information is required. For purposes of convenience, Table 27 summarizes the number of facilities and populations served by treatment processes for the entire U.S., based on 1980 data. When data for a specific geographic area are required, the investigator should request FRDS retrievals from the Computer Systems Staff, EPA Office of Drinking Water, as described in Method 6-5. Completion of these steps will result in the enumeration of the exposed population.

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*K. Karin Wang, EPA-Office of Drinking Water, Washington, DC: personal communication with D. Dixon, Versar Inc., July 27, 1982.

Table 27. Population Served by Drinking Water Treatment Processes for the U.S.

Treatment method	Number of facilities[1]	Population served (x 1,000)
Corrosion control	3,334	68,636
Softening	2,540	39,582
Taste and odor	2,941	97,728
Iron removal	4,275	54,773
Ammoniation	1,071	18,242
Fluoridation	7,150	115,392
Disinfection	20,663	171,666
Untreated	33,781[2]	20,530
Aeration	4,154	64,952
Prechlorination	4,791	76,952
Coagulation	4,615	117,309
Sedimentation	5,020	114,800
Filtration	6,265	117,066

Source: FRDS Data Retrieval FY 1980

[1] A facility is defined as a system serving >25 persons
[2] Primarily ground water systems

Method 6-5. Enumeration of Populations Exposed to Chemical Substances as a Result of Lack of Treatment Processes

Step 1 Identify the treatment process or processes of interest (e.g., coagulation, chlorination, fluoridation).

Step 2 Identify the source(s) of raw water (i.e., surface, ground, or both).

Step 3 Identify the geographic area of interest (e.g., state, county, SMSA, USGS cataloging unit).

Step 4 Request FRDS retrieval from EPA Office of Drinking Water according to the above-identified parameters. Include a listing of the population served in data retrieval request. Exclude utilities that purchase finished or raw drinking water ("P" code) to avoid counting populations twice.

NOTE: Reporting of treatment techniques is not required of states by EPA. The sizes of the populations covered by various treatment methods are generally under-reported. FRDS, therefore, provides only an order-of-magnitude estimate of the size of the exposed population.

6.3.3 Enumeration of Exposed Populations by Type of Distribution System

The distribution system may be a source of exposure to chemical substances. Distribution system components and potential contaminants are listed in Table 28.

It would be ideal to enumerate the populations served by each type of distribution system and component. This approach is not feasible for two major reasons:

- While it is simple to enumerate the customers served by any distribution system, it is nearly impossible to determine the components of any system. Many types of pipe are used in each system, and there is often no record of the type of piping.
- Neither historical nor current data on sales and use of pipe and other components in drinking water distribution systems are available.

Some qualitative generalizations about the relative uses of various pipes are possible. The generalizations are based on the applicability of different pipes in different situations.

Plastic pipe (usually polyvinyl chloride (PVC)) dominates the market in rural water systems. PVC pipe has long been accepted for drinking water supply, which is the main water use in rural areas. In urban areas, fire protection is a major concern, and the high pressures at which water is piped in cities do not allow the use of PVC. It has been estimated that 11.2 million rural Americans were drinking water from PVC pipes in 1979*. The number of urban users is unknown but is thought to be small. The relative proportion of Americans drinking water from PVC pipe is expected to increase, since PVC is used mainly in new construction areas.

In urban areas, the market for water pipe is very competitive. It appears to be fairly evenly split among concrete, ductile iron, asbestos-cement, and steel pipe in the 16-to 24-inch size range, and iron and copper for smaller pipe.† It should be noted that the smaller pipe (less than 16 inches in diameter) accounts for 90 percent of the linear footage of pipe laid.Ψ

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*Bill Nesbitt, President, Uni-Bell Plastic Pipe Assn., personal communication with Gina Hendrickson, Versar, Inc., April 1982.

†John Capita, American Water Works Assn., personal communication with Gina Hendrickson, Versar, Inc., April 1982.

ΨJoe Willett, Concrete Pressure Pipe Assn., Personal communication with Gina Hendrickson, Versar, Inc., April 1982.

Table 28. Distribution System Components and Potential Contaminants

Component	Potential contaminant
Metal pipe (copper, iron, steel)	Metals; microbial products
Pipe joint glue	Organic solvents
Asbestos-cement pipe	Asbestos fibers
Lined pipe and plastic pipe	Plastic monomers, polycyclic aromatic hydrocarbons

A very rough estimate of the urban populations served by different types of pipe can be obtained from the preceding information. In reality, the population exposed via each type may range from less than 25 percent to 100 percent of the urban population, since no two types of pipe are incompatible and it is likely that more than one type is used in a single system.

6.3.4 Enumeration by Use of Monitoring Data

Monitoring data can be used to predict the number of persons drinking water containing a chemical substance. The method extrapolates data on the frequency of detection of the substance. The level of detail achieved by this tool depends on the form, representativeness, and sample size of the data. In its simplest form, the enumeration proceeds as shown in Method 6-6. The assumptions inherent in this very gross estimation include the assumption that the data are independent of the water source (surface or ground water). It must also be assumed that the data represent systems of all sizes, so that the frequency can be applied to the total population. Obviously, these assumptions limit the usefulness of the method; it should only be used in the absence of more refined data.

The investigator can improve this technique by breaking out the total population into groups defined by drinking water source or system size. Table 29 lists the populations served by systems of different sizes and source types. If the monitoring data indicate the source or system size, that information should be used since the following two considerations can greatly affect water quality:

- The fate of pollutants in surface and ground waters differ. While a chemical may volatilize from surface water, it may persist in an aquifer. Biodegradation may proceed at a slower rate in ground water because of lack of oxygen. More partitioning to soils and sediments may occur in groundwater because there is larger surface area available for absorption.

- Pollution (such as vehicle-generated heavy metal contamination) may be anthropocentric and consequently related to system size. Treatment techniques also vary by size of the system; generally, less sophisticated treatment is used in systems serving small populations.

If a pollutant's frequency of detection can be defined by either system size or source, the frequency can be applied to that subpopulation to derive an accurate estimate of the exposed population. Examples of this method are demonstrated in Appendix A-5.

The use of monitoring data to estimate the exposed population is limited in all cases by two assumptions. The sample size must be large

Method 6-6. Enumeration of Exposed Populations by the Use of Monitoring Data

Step 1 Calculate the frequency of detection from the monitoring data; if detected in 10 of 100 samples, the detection frequency is 10 percent.

Step 2 Multiply the detection frequency by the total population of the U.S. (226.5 million).

Table 29. Populations Served by Drinking Water System Size and Source Type[a]

System size	Surface water			Ground water			Surface and ground water		
	No. of systems	No. of persons	Percent of total[b]	No. of systems	No. of persons	Percent of total[b]	No. of systems	No. of persons	Percent of total[b]
25 - 100	1,649	83,000	0.04	22,716	1,145,000	0.54	24,365	1,228,000	0.58
101 - 500	2,644	541,000	0.26	16,554	4,016,000	1.9	19,198	4,557,000	2.16
501 - 1,000	1,378	989,000	0.47	4,969	3,566,000	1.7	6,347	4,555,000	2.17
1,001 - 2,500	1,890	3,157,000	1.5	4,434	7,406,000	3.5	6,324	10,563,000	5.0
2,501 - 5,000	1,257	4,575,000	2.2	1,965	3,038,000	1.4	3,222	7,613,000	3.5
5,001 - 10,000	899	6,265,000	3.0	1,349	9,401,000	4.4	2,248	15,666,000	7.4
10,001 - 100,000	1,550	38,567,000	18.2	2,572	37,107,000	17.5	4,122	75,674,000	35.7
100,000	233	70,303,000	33.2	72	21,725,000	10.3	305	92,028,000	43.5
TOTAL	11,500	124,480,000	58.7	54,631	87,404,000	41.3	66,131	211,884,000	100.0

[a] Does not include persons served by systems with fewer than 25 customers.

[b] May not total exactly because of rounding.

Source: Adapted from USEPA (1981b).

enough that the frequency of detection approximates the frequency of occurrence. The detection limit is the lower limit for estimating the exposed population via this method. Exposure below the detection limit may, however, be significant for certain chemicals.

6.4 Characterization of Exposed Populations

This subsection describes the data sources and procedures for characterizing the exposed population with respect to age and sex. In most exposure assessments, age and sex characterization will not be necessary. However, drinking water intake rates are a function of the individual's age and sex; characterization may be necessary to obtain a precise exposure distribution. If the chemical substance of interest has special effects on particular age classes such as children or the elderly, further characterization of the enumerated population is also indicated. If, for example, a chemical substance is determined to be teratogenic, enumeration of women of child-bearing age may be required.

The simplest and most rapid method of characterizing a large population is to assume that the age and sex distributions approach those of the total U.S. population. Table 12 of Section 2.4 of this report depicts the age and sex distributions by percent for the total U.S. population. These percentages should be applied to the population enumerated via the data sources discussed in the previous section in order to characterize the population exposed via drinking water.

Characterization within specific geographic areas, such as states, townships, and cities, is also straightforward and involves the use of census publications. General Population Characteristics, PC80-1-B Series (Bureau of the Census 1982b) provides the age and sex population data for most defined geographic areas. These data will frequently be provided as total population by age and sex and not as percentages in each age class or sex. The data, therefore, must be converted to a percentage basis. The calculated percentages are then applied to the population enumerated via one of the data sources discussed in the previous section.

6.5 References

Bureau of the Census. 1982a. Statistical abstract of the United States: 1982 (103rd edition). Washington, DC: U.S. Department of Commerce, U.S. Government Printing Office.

Bureau of the Census. 1982b. 1980 Census of population. U.S. summary. General population characteristics. PC80-1-B Series. Washington, DC: U.S. Department of Commerce.

Durfor CN, Becker E. 1964. Public water supplies of the 100 largest cities in the United States, 1962. Geological Survey Water-Supply Paper 1812. Washington, DC: U.S. Geological Survey.

Marks AW. 1980. EPA's computer systems for drinking water. Washington DC: U.S. Environmental Protection Agency, Office of Drinking Water.

USEPA. 1981a. U.S. Environmental Protection Agency. General information on IFD, drinking water supplies, stream gages, reach, and fishkill files and retrieval procedures for hydrologically linked data files. Washington, DC: Water Quality Analysis Branch, Monitoring and Data Support Division.

USEPA. 1981b. U.S. Environmental Protection Agency. Memorandum from B. Coniglio, ODW, to TSPC Solvents Work Group No. 2. Washington, DC: U.S. Environmental Protection Agency.

Versar Inc. 1981. Water supply data base. Inventory of surface water supplies and addendum on a ground water data base structure. Washington, DC: U.S. Environmental Protection Agency, Monitoring and Data Support Division.

APPENDIX A

APPLICATION OF METHODS TO EXAMPLE PROBLEMS

Introduction

The population enumeration methods report is a compilation of data, information resources, and methods. This appendix to the report is designed to illustrate some of the approaches recommended in the methods already discussed. A perusal of these examples will demonstrate that the methods are not necessarily steps that must be explicitly followed; the investigator must be flexible and creative when choosing among available methods and options.

This appendix is arranged as follows:

A-1: Populations Exposed to Chemical Substances in the Ambient Environment
A-2: Populations Exposed to Chemical Substances in the Occupational Environment
A-3: Populations Exposed to Chemical Substances via the Ingestion of Food
A-4: Populations Exposed to Chemical Substances via the Use of Consumer Products
A-5: Populations Exposed to Chemical Substances via the Ingestion of Drinking Water

In some cases the examples are hypothetical; other problems are based on actual problems encountered during the assessment of exposure to chemical substances.

The methods and data used in the compilation of this appendix are detailed in the text of the methods report. Whenever data limitations became apparent in the course of problem-solving, however, those limitations are discussed in the examples.

APPENDIX A-1

POPULATIONS EXPOSED TO CHEMICAL SUBSTANCES IN THE AMBIENT ENVIRONMENT

Problem 1: Attached is a sample computer run of ATM-SECPOP. The model was used to estimate air concentrations of trichloroethane as a result of process emissions from a point source located in Texas. The purpose of the printout is to exemplify procedures used to perform ATM-SECPOP simulation.

```
$ UPGRADE


Is this terminal a VT100 (Y/N)? N
```

```
Enter an operation: AUTOHELP

Operations include:             FILE MANAGEMENT (FM)
                                GRAPHICS (G)
                                MODELING (M)
                                STATISTICS (S)
                                TABULAR OUTPUT (TO)
                                ESTIMATION (E)

Enter an operation: MODELING

Model names by media:           Air:            ATM (A)
                                Water:          EXAMS
                                Soil:           SESOIL (S)
                                Multimedia:     ENPART
                                                *UTMTOX (U)
 * Not yet implemented

Enter a model name: ATM

    The title of the run can be up to eighty characters long.  The
wording of the title is left to the user but typically should show
whether latitude and longitude, or zipcode, were used to identify
the emission site's location.

        Examples:

  **CHEMICAL XY, PLACE ANYWHERE, POPULATION BASED ON ZIPCODE -- 4/7/81**

Press RETURN to continue:
  **CHEMICAL PQ, PLACE SOMEWHERE, LAT/LONG USED -- 10/12/79**

Enter the title of this run: Site A, 1,1,1 - Trichloroethane

    The user should enter DEFAULT.  (In future versions of the system,
users will be able to supply alternatives to the default values).
Entering DEFAULT causes the following values to be used by ATM:

        Number of concentration points in each
         of the sixteen wind directions:            40
        Number of rings:                            10
        Ring distances (km):                        0.5, 1, 2, 3, 4,
                                                    5, 10, 15, 25, 50
        Number of concentration points per ring:    4

Enter the default status: DEFAULT

    The name of the point source can be up to twenty-four characters
long. This information must be supplied by the user at present.

Enter the name of the point source: Site A

    Type LAT/LONG or ZIPCODE to indicate the kind of source location
identifier you will use.  The source location identifier is LAT/LONG
if the user knows the geographic coordinates of the site, or ZIPCODE
if only the zipcode is known.  If both are available, the user should
use LAT/LONG.  Generally, more accurate results will be obtained if
the correct LAT/LONG is used.


Press RETURN to continue:
```

```
Enter the source location identifier: LAT/LONG

    The latitude is entered in degrees, minutes, and seconds.
Each of the components of the latitude should be separated from
the others by one space.

        Example:        N 34 32 10

This information must be supplied by the user at present.

Enter latitude in degrees, minutes, and seconds: N 28 59 10

    The longitude is entered in degrees, minutes, and seconds.
Each of the components of the longitude should be separated from
the others by one space.

Example:        W 76 54 32

This information must be supplied by the user at present.

Enter longitude in degrees, minutes, and seconds: W 95 24 45

    This model uses annual weather data for the selected locality.  The stations
within the indicated radius are located in the table below.  Choose the station
which best represents the source location's weather conditions.  If you are un-
sure which to choose, it is usually appropriate to select the closest one.  Type
the four digit station index number to indicate your choice.
    Weather stations within   75.0 km of the site:
Press RETURN to continue:
```

```
INDEX       STATION NAME            LAT / LON        PERIOD OF  STABILITY  DISTANCE
NUMBER                           deg min   deg min    RECORD     CLASSES     (km)
 0065   GALVESTON/SCHOLES TX  N 29 16 / W 94 52   1956-1960      6         61.5
 1410   HOUSTON/ELLINGTON TX  N 29 37 / W 95 10   1966-1970  6 DAYNITE     74.0
 0062   HOUSTON/HOBBY 129 TX  N 29 39 / W 95 17   1964-1968      6         74.8

Enter the four digit station index number: 0065

    The name of the emission type may be up to eight characters
long.  This name will be used to label the model output.  The
name you choose generally depends on the specific kind of pollu-
tant emission at the point source facility.  The emission type
name must be supplied by the user at present.

        Examples:       PROCESS
                        STORAGE

Enter the name of the emission type: PROCESS

    The source height defines the release height of the emission
in meters (m).  This information must be supplied by the user at
present.

Enter the PROCESS emissions source height in (m): 15.24

    The vent radius defines the radius in meters (m) of the point
source emission through a vent.  This information must be supplied
by the user at present.


Press RETURN to continue
```

```
Enter the vent radius for PROCESS emissions in (m): .026

    The vent gas temperature defines the discharge temperature in
degrees Kelvin of the emissions through a vent.  This information
must be supplied by the user at present.

Enter the PROCESS vent gas temp in degrees (K): 311

    The ejection velocity defines the discharge ejection velocity
of the emissions in meters per second (m/s).  This information
must be supplied by the user at present.

Enter the ejection velocity for PROCESS emissions in (m/s): 1.524

    The emission rate defines the source strength of the emissions
in grams per second (g/s).  This information must be supplied by
the user at present.

Enter the PROCESS emission rate in (g/s): 2.755

    The name of the pollutant may be up to ten characters long.
It should be selected so that it identifies the chemical uniquely.

        Example:        PMN 81-XXX

This information must be supplied by the user at present.

Enter the name of the pollutant: 1,1,1-TCE

Press RETURN to continue:
    The pollutant state identifier is GAS if the pollutant is
gaseous, or PARTICLE if the pollutant is a particulate.  This
information must be supplied by the user at present.

Enter the pollutant state: GAS

    The molecular weight of the gas must be supplied by the user
at present.

Enter the molecular weight: 133.4

    The atmospheric half life of the pollutant is entered in sec-
onds.  This information must be supplied by the user at present.
Please use the format shown in the examples, where 'E' precedes
the exponent in powers of ten.

        Examples:       1.557E8
                        1.020E9

Enter the half life in (s): 1.577E8

Control commands:

BACK            will return the user to the previous prompt.
CLEAR           will return the user to the Operation prompt.
EXIT            will return the user to VAX/VMS.
HELP            will display the appropriate HELP message.
GO              will begin processing of the user's fully
                 specified request.
AUTOHELP        will cause the HELP message to be displayed
Press RETURN to continue:
```

```
                for each prompt.
NOAUTOHELP      will cancel AUTOHELP.
RECAP           will display the session summary.
DATASET         will allow the user to change the current dataset.

Enter GO to begin processing: GO
```

```
 Site A, 1,1,1 - Trichloroethane

 PASQUILL STABILITIES NOT USED--STABILITIES FOUND IN SUBROUTINE SIGMA

 BRIGGS DISPERSION VALUES

 NUMBER OF WIND SPEEDS=    6
         NUMBER OF WIND DIRECTIONS=   16
         NUMBER OF STABILITIES=    6
         STABILITIES USED---    1    2    3    4    5    6

 SIGMAX(M) FOR EACH STABILITY IN THE TABLE
 STABILITY  SIGMAX
    1        3200.
    2        1600.
    3         800.
    4         500.
    5         200.
    6         100.

Press RETURN to continue:
```

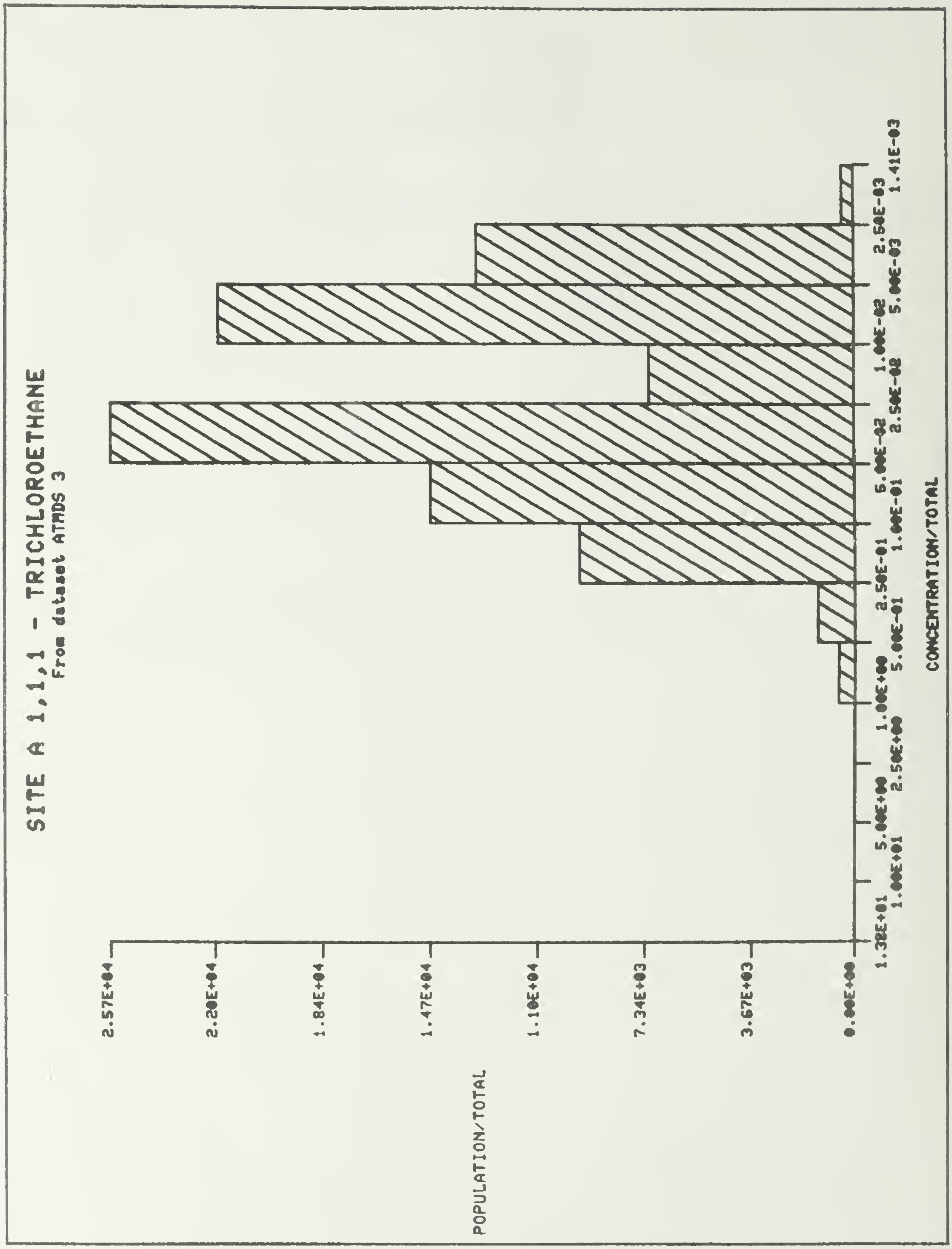
```
DISTANCE(M) OF THE 40 CONCENTRATION POINTS IN EACH OF THE 16 WIND DIRECTIONS
ID NO.  DISTANCE    ID NO.  DISTANCE    ID NO.  DISTANCE    ID NO.  DISTANCE
   1        125.       2        250.       3        375.       4        500.
   5        625.       6        750.       7        875.       8       1000.
   9       1250.      10       1500.      11       1750.      12       2000.
  13       2250.      14       2500.      15       2750.      16       3000.
  17       3250.      18       3500.      19       3750.      20       4000.
  21       4250.      22       4500.      23       4750.      24       5000.
  25       6250.      26       7500.      27       8750.      28      10000.
  29      11250.      30      12500.      31      13750.      32      15000.
  33      17500.      34      20000.      35      22500.      36      25000.
  37      31250.      38      37500.      39      43750.      40      50000.

LATITUDE AND LONGITUDE OF POINT SOURCES
         NAME              LATITUDE                LONGITUDE
                           DEGREES MINUTES SECONDS DEGREES MINUTES SECONDS
Site A                         28.     59.     10.     95.     24.     45.

Press RETURN to continue!
```

```
 EMISSION TYPE  HEIGHT(M)  PKAPPA(M)  QKAPPA(M)  AT(K)  ST(K)  RAD(M)  VEL(M/S)
    PROCESS         15.24       0.08       3.56  293.0  311.0   0.026     1.524

 WIND SPEEDS(M/S) FOR PROCESS  EMISSION HEIGHT AS A FUNCTION OF EACH STABILITY
                      WIND SPEED CLASS    1        2        3        4        5       6
                                     *   0.77     2.57     4.37     6.94     9.77   12.35
                           STABILITY 1   0.79     2.65     4.50     7.15    10.06   12.72
                           STABILITY 2   0.79     2.65     4.50     7.15    10.06   12.72
                           STABILITY 3   0.80     2.68     4.56     7.24    10.19   12.88
                           STABILITY 4   0.82     2.74     4.66     7.39    10.41   13.16
                           STABILITY 5   0.89     2.98     5.06     8.04    11.32   14.31
                           STABILITY 6   0.97     3.24     5.51     8.75    12.32   15.57
                         * CENTRAL WIND SPEEDS AT STANDARD 10(M) HEIGHT - (ORNL)
 GRASS COVER  1.0
 AFTERNOON MIXING HEIGHTS(M) = 1345.
 NOCTURNAL MIXING HEIGHTS(M) =  501.

          DATA FOR A GASEOUS POLLUTANT : 1,1,1-TCE
          DIFFUSION CONSTANT FOR WASHOUT =   9.419E-06  (M2/S)
          HALF LIFE =   1.577E+08  (S)

 EMISSION RATE FROM POINT SOURCE TYPE - PROCESS  =   2.755E+00  (G/S)

Press RETURN to continue:
```

ATM will now begin processing the user's input. The length of time required may be several minutes, after which the results of the model will be displayed.

```
Site A, 1,1,1 - Trichloroethane
POLLUTANT ; 1,1,1-TCE                                    SOURCE ; Site A                          EMISSION TYPE ; PROCESS
REPORTED TABULAR VALUES WITHIN INDIVIDUAL SECTOR SEGMENTS : ANNUAL AVERAGE CONCENTRATION (UG/M3)
                                                             POPULATION (PERSONS)
                                                           * POPULATION EXPOSURE (UG/YR)
* POPULATION EXPOSURE = ANNUAL AVERAGE CONCENTRATION * POPULATION * ANNUAL BREATHING RATE(22M3/DAY * 365 DAYS/YR)

DISTANCES (KM) :  0.0- 0.5  0.5- 1.0  1.0- 2.0  2.0- 3.0  3.0- 4.0  4.0- 5.0  5.0-10.0 10.0-15.0 15.0-25.0 25.0-50.0

SECTOR MID-ANGLE
   N        0.0   1.380E+01 6.077E+00 2.386E+00 9.402E-01 5.045E-01 3.181E-01 1.459E-01 5.363E-02 2.532E-02 1.005E-02
                          0         0         0         0         0      1075      1939         0     11663      1838
                  0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 2.746E+06 2.272E+06 0.000E+00 2.371E+06 1.483E+05

 NNE       22.5   5.046E+00 2.380E+00 9.900E-01 3.938E-01 2.101E-01 1.316E-01 5.973E-02 2.159E-02 1.012E-02 3.979E-03
                          0         0         0         0      1574      1061      2654         0         0     11570
                  0.000E+00 0.000E+00 0.000E+00 0.000E+00 2.655E+06 1.121E+06 1.273E+06 0.000E+00 0.000E+00 3.697E+05

  NE       45.0   3.458E+00 2.221E+00 1.103E+00 4.444E-01 2.307E-01 1.406E-01 6.086E-02 2.033E-02 9.178E-03 3.448E-03
                          0         0         0         0       605         0         0         0        16       242
                  0.000E+00 0.000E+00 0.000E+00 0.000E+00 1.121E+06 0.000E+00 0.000E+00 0.000E+00 1.179E+03 6.699E+03

 ENE       67.5   1.465E+00 9.800E-01 5.049E-01 2.029E-01 1.042E-01 6.286E-02 2.674E-02 8.654E-03 3.828E-03 1.407E-03
                          0         0         0         0         0         0         0      1024       143       401
                  0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 7.116E+04 4.396E+03 4.532E+03

   E       90.0   2.289E+00 1.148E+00 5.385E-01 2.147E-01 1.115E-01 6.801E-02 2.951E-02 9.911E-03 4.494E-03 1.702E-03
                          0         0         0         0         0         0       214         0         0         0
                  0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 5.070E+04 0.000E+00 0.000E+00 0.000E+00

 ESE      112.5   2.283E+00 1.056E+00 4.747E-01 1.898E-01 9.970E-02 6.149E-02 2.719E-02 9.439E-03 4.328E-03 1.637E-03
                          0         0         0         0       798       924      3082       528         0         0
                  0.000E+00 0.000E+00 0.000E+00 0.000E+00 6.388E+05 4.563E+05 6.729E+05 4.002E+04 0.000E+00 0.000E+00

  SE      135.0   3.279E+00 1.578E+00 6.708E-01 2.685E-01 1.433E-01 8.966E-02 4.059E-02 1.459E-02 6.805E-03 2.620E-03
                          0         0         0       224         0       358      6821         0         0         0
                  0.000E+00 0.000E+00 0.000E+00 4.830E+05 0.000E+00 2.577E+05 2.223E+06 0.000E+00 0.000E+00 0.000E+00

 SSE      157.5   2.607E+00 1.061E+00 4.002E-01 1.587E-01 8.640E-02 5.515E-02 2.579E-02 9.761E-03 4.633E-03 1.805E-03
                          0         0         0         0         0         0         0         0         0         0
                  0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00

   S      180.0   8.067E+00 3.152E+00 1.219E+00 4.811E-01 2.584E-01 1.631E-01 7.491E-02 2.763E-02 1.291E-02 4.934E-03
                          0         0         0         0         0         0         0         0         0         0
                  0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00

 SSW      202.5   5.488E+00 2.178E+00 8.282E-01 3.280E-01 1.777E-01 1.129E-01 5.247E-02 1.965E-02 9.235E-03 3.535E-03
                          0         0         0         0         0         0         0         0         0         0
                  0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00

  SW      225.0   6.604E+00 2.986E+00 1.186E+00 4.688E-01 2.512E-01 1.581E-01 7.229E-02 2.640E-02 1.229E-02 4.700E-03
                          0         0         0         0         0         0       530         0         0       439
                  0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 3.076E+05 0.000E+00 0.000E+00 1.657E+04

 WSW      247.5   4.554E+00 2.031E+00 7.959E-01 3.165E-01 1.709E-01 1.083E-01 5.001E-02 1.851E-02 8.644E-03 3.281E-03
                          0         0         0         0         0       411       857         0       306       692
                  0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 3.575E+05 3.442E+05 0.000E+00 2.124E+04 1.823E+04

   W      270.0   8.407E+00 3.680E+00 1.487E+00 5.888E-01 5.141E-01 1.969E-01 8.939E-02 3.229E-02 1.492E-02 5.646E-03
                          0         0         0       558         0         0         0      1413       689      4043
                  0.000E+00 0.000E+00 0.000E+00 2.638E+06 0.000E+00 0.000E+00 0.000E+00 3.664E+05 8.257E+04 1.833E+05

 WNW      292.5   1.086E+01 4.505E+00 1.681E+00 6.612E-01 3.585E-01 2.282E-01 1.063E-01 3.988E-02 1.883E-02 7.342E-03
                          0         0         0         0         0         0         0         0      3529      6936
                  0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 3.529E+05 4.089E+05

  NW      315.0   1.263E+01 5.419E+00 2.075E+00 8.185E-01 4.422E-01 2.804E-01 1.298E-01 4.829E-02 2.275E-02 8.877E-03
                          0         0         0         0         0         0      1595         0       171      4950
                  0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 1.654E+06 0.000E+00 3.124E+04 3.536E+05

 NNW      337.5   9.129E+00 3.808E+00 1.410E+00 5.546E-01 3.019E-01 1.928E-01 9.075E-02 3.458E-02 1.755E-02 6.434E-03
                          0         0         0         0         0      2379      7401      1637       958      4121
                  0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 3.684E+06 5.313E+06 4.545E+05 1.350E+05 2.129E+05

Press RETURN to continue:
 50.0 KM RADIUS POPULATION EXPOSED AND EXPOSURE OF 1,1,1-TCE
 RESULTING FROM PROCESS  EMISSIONS AT Site A

                               CUMULATIVE           * CUMULATIVE
 CONCENTRATION LEVEL   POPULATION EXPOSED   POPULATION EXPOSURE
       (UG/M3)              (PERSONS)              (UG/YR)
      1.380E+01                  0                0.000E+00
      1.000E+01                  0                0.000E+00
      5.000E+00                  0                0.000E+00
      2.500E+00                  0                0.000E+00
      1.000E+00                  0                0.000E+00
      5.000E-01                558                2.638E+06
      2.500E-01               1857                5.867E+06
      1.000E-01              11422                1.874E+07
      5.000E-02              26944                2.883E+07
      2.500E-02              51794                3.497E+07
      1.000E-02              58975                3.589E+07
      5.000E-03              80909                3.718E+07
      2.500E-03              93995                3.760E+07
      1.407E-03              94396                3.760E+07

 * CUMULATIVE POPULATION EXPOSURE WAS ARRIVED AT BY ACCUMULATING
   POPULATION EXPOSURES ASSOCIATED WITH INDIVIDUAL SECTOR SEGMENTS.
Press RETURN to continue:
```

```
Operations include:            FILE MANAGEMENT (FM)
                               GRAPHICS (G)
                               MODELING (M)
                               STATISTICS (S)
                               TABULAR OUTPUT (TO)
                               ESTIMATION (E)

Enter an operation: EXIT
Type BACK if you want to save temporary datasets:
```

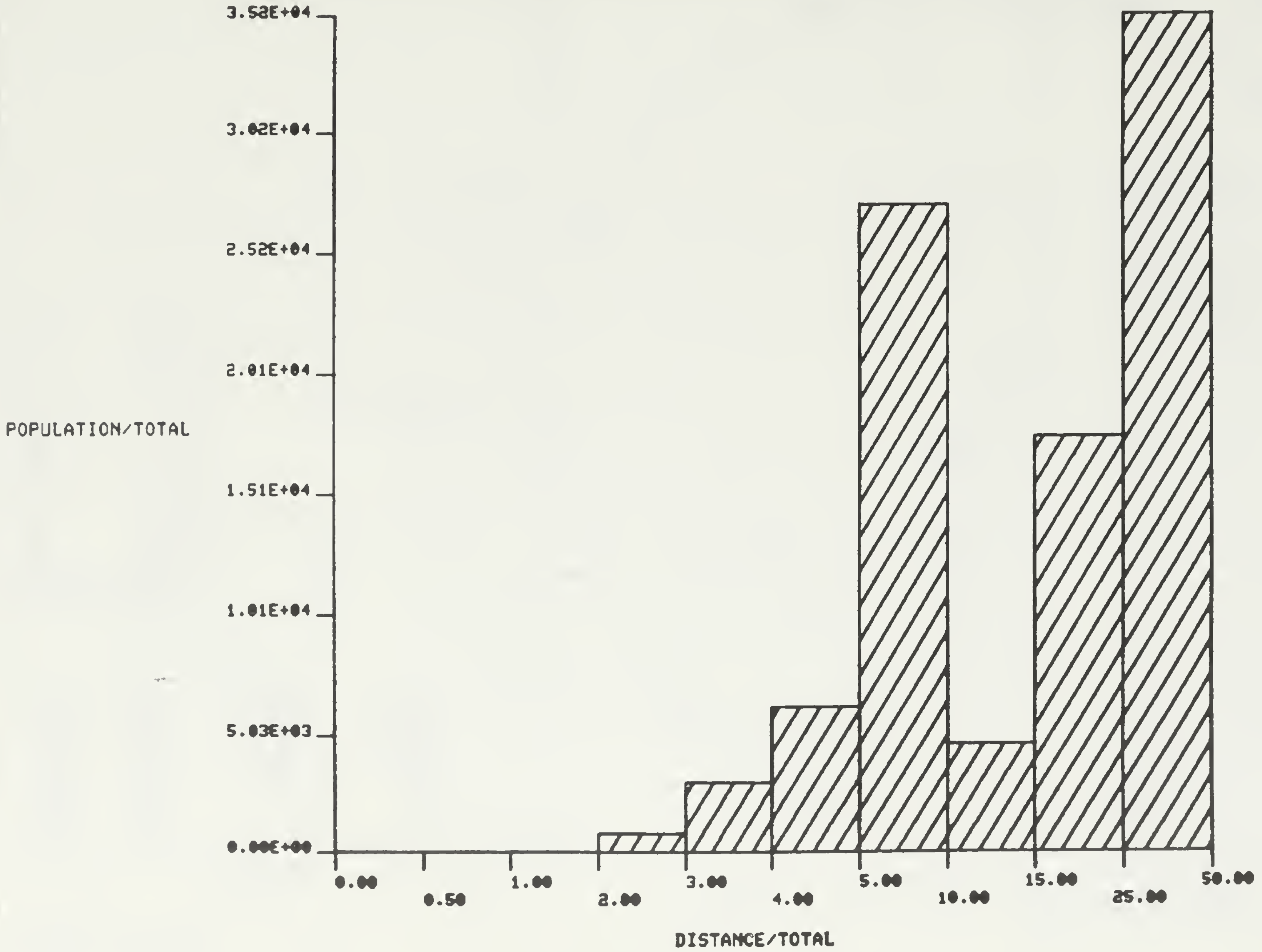


SITE A 1,1,1 - TRICHLOROETHANE

From dataset ATMDS 3

SITE A 1,1,1 - TRICHLOROETHANE

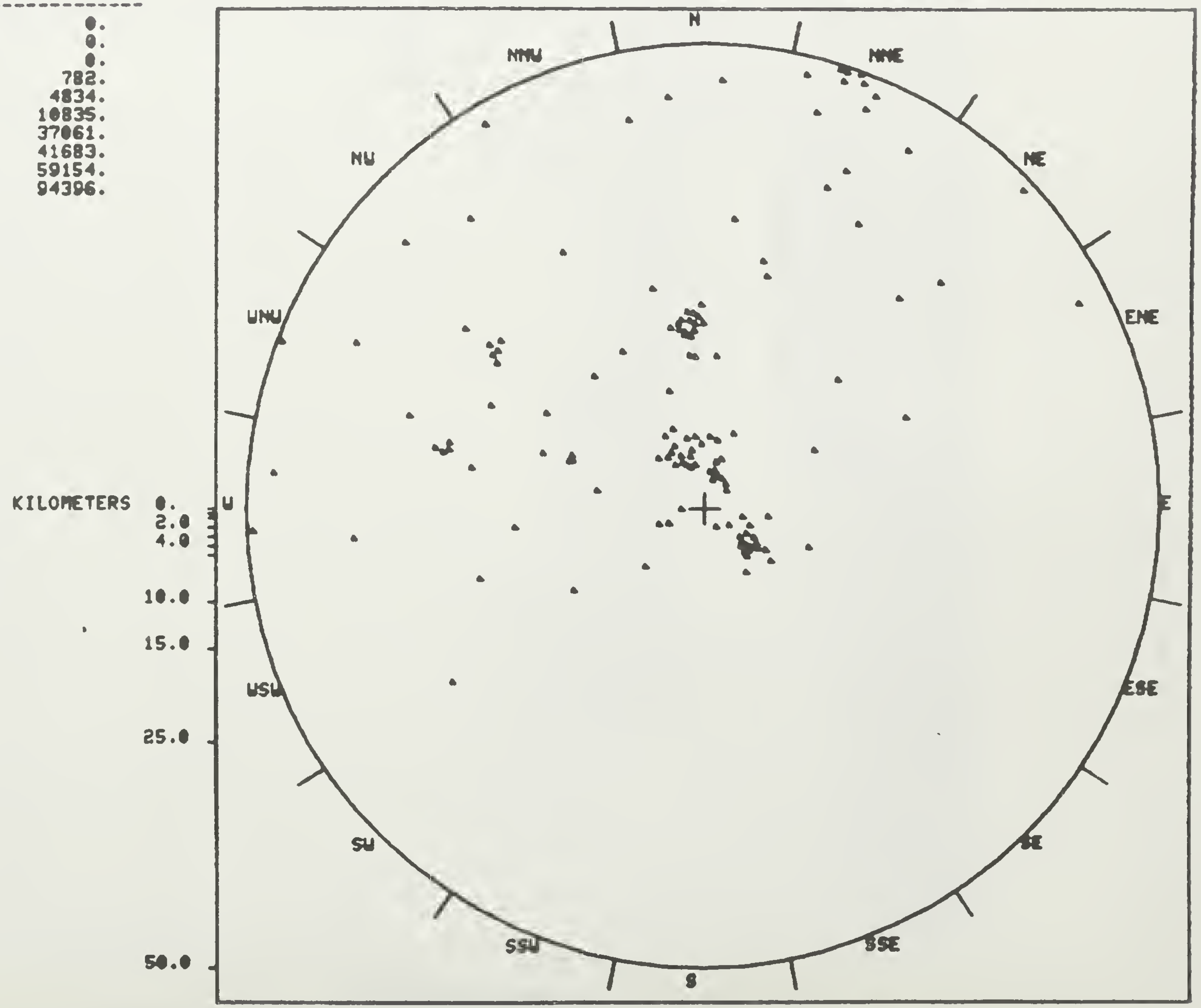
From dataset ATMDS 3



```
HE PLOT CENTER IS AT:
ATITUDE    28.9875
ONGITUDE    95.4125

    RADII              POPULATION
From       To       Within Ring      Cumulative
-----------------------------------------------
 0.00      0.50            0              0.
 0.50      1.00            0              0.
 1.00      2.00            0              0.
 2.00      3.00          782            782.
 3.00      4.00         4052           4834.
 4.00      5.00         6001          10835.
 5.00     10.00        26226          37061.
10.00     15.00         4622          41683.
15.00     25.00        17471          59154.
25.00     50.00        35242          94396.


UADRANT TOTALS:
ector  Population
N           16515
NNE         16859
NE            863
ENE          1568
E             214
ESE          3559
SE           8838
SSE           338
S               0
SSW             0
SW            969
WSW          2266
W            6703
WNW         10461
NW           6727
NNW         18516
```

SITE A 1,1,1 - TRICHLOROETHANE

Graphic display of ATM study area produced by RADII5


N
NNW
NNE
NW
NE
WNW
ENE
W
E
WSW
ESE
SW
SE
SSW
SSE
S
KILOMETERS
0.
2.0
4.0
10.0
15.0
25.0
50.0

NOTE: The following problem and solution is presented to demonstrate a possible approach for enumerating populations around point sources that are too numerous to deal with individually. Approaches, however, will have to be developed on a case-by-case basis for exposure assessments depending upon the availability of locational information and within the time and manpower constraints of the effort.

Problem 2: A chemical substance is known to be released from 100 point sources located in metropolitan areas throughout the United States. Using generic release characteristics, the following range of atmospheric concentrations has been estimated, via ATM, for radial rings within a 10 kilometer radius of the prototype source:

Radial Distance (km)	Concentration (ug/m^3)
0.0 - 0.5	1.4×10^0 - 7.0×10^0
0.5 - 1.0	2.0×10^{-1} - 1.2×10^0
1.0 - 2.0	4.6×10^{-2} - 2.4×10^{-1}
2.0 - 3.0	1.5×10^{-2} - 6.9×10^{-2}
3.0 - 4.0	7.3×10^{-3} - 3.3×10^{-2}
4.0 - 5.0	4.4×10^{-3} - 2.0×10^{-2}
5.0 - 10.0	1.9×10^{-3} - 8.7×10^{-3}

Estimate the population exposed at each concentration.

Solution: Since no other information on the location of the 100 sources is available, it is assumed they are located in metropolitan areas (SMSAs). To estimate the size of the population within each ring, the average population density of metropolitan areas in the U.S., 120 persons/km^2 (Table 8), was multiplied by the areas of each ring. Following are the results:

Radial Distance (km)	Prototype Ring Population
0.0 - 0.5	96
0.5 - 1.0	288
1.0 - 2.0	1136
2.0 - 3.0	1888
3.0 - 4.0	2624
4.0 - 5.0	3392
5.0 - 10.0	28,320

Since there are 100 sources nationwide and the prototype is assumed to be representative of all sources, the exposed population in each ring times 100 is equal to the total exposed population at each concentration range as follows:

Radial Distance (km)	Concentration Range (ug/m^3)	Exposed Population
0.0 - 0.5	1.4×10^{0} - 7.0×10^{0}	9,600
0.5 - 1.0	2.0×10^{-1} - 1.2×10^{0}	28,800
1.0 - 2.0	4.6×10^{-2} - 2.4×10^{-1}	113,600
2.0 - 3.0	1.5×10^{-2} - 6.9×10^{-2}	188,800
3.0 - 4.0	7.3×10^{-3} - 3.3×10^{-2}	262,400
4.0 - 5.0	4.4×10^{-3} - 2.0×10^{-2}	339,200
5.0 - 10.0	1.9×10^{-3} - 8.7×10^{-3}	2,832,000

Problem 3: Area Source (Site Specific) - Chemical X is released as a result of vehicular emissions. Enumerate the population in the San Antonio SMSA that is exposed to different concentrations of chemical X given the following information: modeling of area source concentrations using meteorological factors characteristic of the San Antonio area determines that the atmospheric concentration of chemical X in urban areas is Y mg/m^3 and Z mg/m^3 in rural areas.

Solution: This problem was solved via application of Method 2-4 as follows:

The Bureau of Census publication, Number of Inhabitants (PC 80-1-A45), for 1980 provides the following data for the San Antonio SMSA. (Bureau of Census 1983a, Table 12, p. 52):

urban portion : population 985,149
rural portion: population 86,805

Therefore, populations are exposed to different concentrations of chemical X as follows:

y mg/m^3 = 985,149
z mg/m^3 = 86,805

Problem 4: Prototype Area Source - Chemical X is released as a result of the combustion of fossil fuels in home and industrial heating systems. The atmospheric concentration is directly related to population density and geographic location. Enumerate the population exposed to the different concentrations of chemical X according to the following modeling results;

	Concentration (mg/m^3)		
	Urbanized Area	Urban Area	Rural Area
Northeast	100	60	20
South	20	10	1
North Central	80	40	10
West	50	40	5

Solution: This problem was solved via application of Method 2-4 as follows:

Table 10 of the methods report provides 1980 population data for the U.S. based on census geographic regions. Data for the regions of interest are as follows:

	Population (x 10^3)		
	Urbanized	Other Urban	Rural
Northeast	35,520	3,484	10,232
South	39,639	10,743	24,967
North Central	32,822	8,644	17,388
West	31,130	5,083	6,953

These various population figures are readily matched up with the corresponding concentrations to yield the following results:

Concentration	Population (x 10^3)	
100	35,520	
80	32,822	
60	3,484	
50	31,130	
40	13,727	(8,644 + 5,083)
20	49,871	(39,639 + 10,232)
10	28,131	(10,743 + 17,388)
5	6,953	
1	24,967	

Problem 5: Line Source Example - Chemical X is imported to Baltimore, MD, and is distributed by railroad tank car to manufacturing sites in Richmond, VA; Pittsburgh, PA; Louisville, KY; and Newark, NJ. Leakage of chemical X along the transportation corridors results in an inhalation exposure to residents in the vicinity. Modeling of atmospheric concentrations based on the emission of X estimates the concentration to be z mg/m^3 within 0.5 mile of the rail lines. Enumerate the population exposed. Characterize the population by age and sex.

Solution: This problem was solved via application of Method 2-5 as follows:

Road atlases were consulted to determine distances between cities and the identity of central cities of SMSAs located on or very near straight lines drawn from Baltimore to each terminal city. Population density of each SMSA was calculated from 1980 data in the Bureau of Census publication, Number of Inhabitants (individual states). This reference provided total populations for each SMSA as well as the area (square miles) of each individual county. County areas were summed within an SMSA to determine total SMSA area. The number of people per square mile was then calculated. This information will be obtained much faster following publication of the U.S. Summary for Number of Inhabitants (mid 1983). The U.S. summary will list each SMSA along with population, land area, and population density.

Table 30 summarizes data and results for each route. Note that the Baltimore to Newark route presented problems that could not be solved by conventional use of the methodology. There are six SMSAs along the Baltimore-Newark corridor, including the end points. Each of these SMSAs borders directly on the next with no nonmetropolitan territory in between. Because of this, and because the subject SMSAs have odd shapes, the sum of all radii along the route calculated according to the previously discussed methods exceeds the actual distance between the terminal cities. Therefore, actual distances across SMSAs (straight lines through the central cities) were determined from road maps. The remaining three routes were analyzed by the conventional methods.

Table 30. Line Source Corridor Distances, Population Density, and Population Exposed in Problem 5

SMSA	Distance [a] (miles)	Density[b] (persons/mi^2)	Number of persons (x 10^3)
Baltimore to Newark (total distance 168 mi.)			
Baltimore	34	968	32.9
Wilmington	40	479	19.2
Philadelphia	46	1336	61.5
Trenton	11	1357	14.9
New Brunswick	15	1886	28.3
Newark	22	1954	43.0
Baltimore to Pittsburgh (total distance 218 mi.)			
Baltimore	27	968	26.1
Hagerstown	24	248	6.0
Pittsburgh	31	741	23.0
non-SMSA			
Baltimore to Hagerstown	25	38	1.0
Hagerstown to Pittsburgh	111	69	7.7
Baltimore to Louisville (total distance 598 mi.)			
Baltimore	27	968	26.1
Louisville	21	646	13.6
non-SMSA			
Baltimore to Louisville	550	38	20.9
Baltimore to Richmond (total distance 144 mi.)			
Baltimore	19[c]	968	18.4
Washington, D.C.	49	1090	53.4
Richmond	26	296	7.7
non-SMSA			
Washington, D.C to Richmond	50	38	1.9
TOTAL Population Exposed			405.6 x 10^3

---

[a] Distance in miles is equivalent to areas in square miles because width of corridor is 1 mile.

[b] Source: Number of Inhabitants.

[c] Adjusted to reflect fact that Baltimore and Washington, D.C., SMSAs are adjacent (compare treatment of Balitmore-Newark route in text).

Except for the Baltimore-Newark route, each SMSA is considered to be a circle. In Table 30, "distance" is equivalent to the radius of this circle in the case of a terminal SMSA, and equivalent to the diameter in the case of an intermediate SMSA. Radius or diameter was calculated from the area of the SMSA by the familiar formula, $A = \pi r^2$. Nonmetropolitan mileage was calculated as the difference between total length of route and the sum of all SMSA radii. The density of population in nonmetropolitan areas is taken for the appropriate region from Table 8 of the text.

The calculated total exposed population of 405.6×10^3 was characterized by age and sex. Proportions of each age and sex group were calculated from data in Table 12 of the text. Results are summarized in Table 31.

Table 31. Characterization of Exposed Population for Line Source Problem 5

Age Group	Male population (x 10^3)	Female population (x 10^3)
5	15.0	14.2
5 - 9	15.3	14.6
10 - 14	16.7	16.0
15 - 19	19.3	18.6
20 - 24	19.1	19.1
25 - 34	32.9	33.5
35 - 44	22.5	23.4
45 - 54	19.7	21.1
55 - 64	18.2	20.7
65 - 74	12.1	15.8
75 - 84	5.1	8.7
85+	1.2	2.8

(Numbers may not add to total due to rounding)

APPENDIX A-2

POPULATIONS EXPOSED TO CHEMICAL SUBSTANCES IN THE OCCUPATIONAL ENVIRONMENT

Problem 1: Substance Y is a mineral contaminant of phosphate rock used in the preparation of fertilizers. How many persons are occupationally exposed to Y as a result of production, sales, and use of phosphate rocks and fertilizers?

Solution: This problem was solved via application of Method 3-1 and 3-2 as follows:

Step 1 - List of Establishments (from SIC manual)

- SIC 0711 - Soil Preparation Services (use)
- SIC 1475 - Phosphate Rock Mining (production)
- SIC 2874 - Phosphatic Fertilizers (production)
- SIC 5191 - Farm Supplies/Wholesale Distribution (Phosphate Rock - ground) (sales)
- SIC 5261 - Retail Nurseries, Lawn and Garden Supply Stores (fertilizers) (sales)

Step 2 - Determine Sources
(Economic Censuses)

Step 3 - Choose Data
(see Table 32)

Step 4 - Sum and qualification of data

1) 8,578
2) 5,900
3) 10,100
4) 35,772
5) 36,360

96,710 total exposed

1. SIC 0711 - is the only 4-digit code in the 071 class; populations reported for 071 and 0711 are equivalent. However, handling phosphatic fertilizers would only account for part of the activity described for this service industry.

Table 32. Employment by SIC Code for Producers and Users of Phosphate Fertilizers

SIC Found	Number of employees	Census cited
071	8,578 (paid employees)	1978 Agriculture
1475	5,900 (year average for production, development, and exploration workers for all types of operations)	1977 Mineral Industries
2874	10,100 (production workers)	1977 Manufactures
5191	35,772 (paid employees)	1977 Wholesale Trade
526	36,360 (paid employees)	1977 Retail Trade

2. SIC 1475 - the number reported would be representative of those actually exposed.

3. SIC 2874 - the number reported would again be representative of works actually exposed.

4. SIC 5191 - the number reported reflects a certain overestimation of those employees actually exposed to products containing contaminated phosphate rocks.

5. SIC 526 - similar to 0711, 5261 is the only 4-digit code in the 526 class; nonetheless, the reported number of paid employees is a gross overestimate of those actually exposed. (Exposure would be limited to accidental release of fertilizer from its packaging.)

Problem 2: Chemical Z is a reagent used in typing blood. (Typing is done in laboratories and is a common lab experiment in high school biology classes.) How many persons are exposed to chemical Z? Characterize that population by age and sex.

Solution: This problem was solved via application of Method 3-3 as follows:

Assumptions -(1) High school biology students are exposed in the classroom as is the teacher.

The exposed population will include:

- Medical/clinical technicians running tests.
- Biology teachers using this curriculum.
- Biology students of the appropriate grade.

Option 2 - Contact associations/appropriate representative organizations.

- National Association of Biology Teachers, Inc.
  Reston, Virginia 471-1134

Dr. Moyer: This test is done very infrequently because of resulting social problems it has posed with students and their families. Where it is done, this test is part of the 10th grade biology curriculum.

- National Science Teachers Association
  Washington, D.C. 328-5800

Dina Weiss: From the U.S. Registry of Junior and Senior High School Science and Math Teaching Personnel: most current estimate of biology teachers for grades 9 through 12 is 34,412 (at least 75% of national total).

- National Center of Educational Statistics
  (U.S. Department of Education), Washington, D.C. 436-7900

- Survey of national student enrollment for 1972 - 1973 school year in public schools, Biology I (10th grade) indicates 2,049,000 students.

- Statistics show that in 1972 the ratio of public to private high school students (grades 9-12) was about 10 to 1 (13,913,000/1,300,000).

- Statistics also show that since 1976, high school student enrollment in general has declined. 1982 survey results of public and private high school total enrollment shows about one million fewer students.

Option 3 - Occupation by Industry, 1970

- Health Technologists and Technicians employed at hospitals and with other health services.

Male	Female
16 to 24 = 12,911 + 2,050	16 to 24 = 42,824 + 12,379
25 to 44 = 25,545 + 7,169	25 to 44 = 55,150 + 23,195
45 to 64 = 7,917 + 4,720	45 to 64 = 22,616 + 8,937
65 + = 365 + 404	65 + = 1,413 + 694

Data Summation

(i) • 10th grade biology students best fit into the 15 to 19 year age category. From 1980 Census data (Table 12), the ratio of 15 to 19 year old men to women = $\frac{10,751,544}{10,410,123}$ = 1.03, or 0.508:0.492.

- In the 1972 - 1973 school year there were 2,049,000 Biology I students in public high school; and an estimated 204,900 Biology I students in private high school; totaling 2,253,900 Biology I students in 1972 - 1973. If general enrollment has decreased by about 10% since 1972, the current total would equal 2,028,510 high school students.

- Male: 16 to 24 = 1,030,483 Female: 16 to 24 = 998,027.

(ii)

- 34,412 currently registered high school biology teachers who could teach using the blood type test.

- Age and sex characterization for this special subpopulation is derived from the generic percentages of total employed in the "Professional, Technical, and Kindred" occupation classes (text Table 15):

Male	Female
16 to 24 = 7.2%	16 to 24 = 7.5%
25 to 44 = 33.5%	25 to 44 = 18.3%
45 to 64 = 16.9%	45 to 64 = 12.7%
65 + = 2.0%	65 + = 1.4%
~60%	~40%

The total percent ratio of male to female biology teachers (60 to 40) from the professional, technical, and kindred breakdown supplied by the 1970 occupational census (Table 15), agrees with the estimate of male to female biology teachers supplied by the National Science Teachers Association's registry.

(iii)

- Data for Health Technologist and Technicians employed in 1970 have been reported; the distribution is assumed to remain the same.

(iv)

Age Class	Male	Female
• 16 - 24	1,047,922	1,055,811
Students	(1,030,483)	(998,027)
Teachers	(2,478)	(2,581)
Technicians & technologists	(14,961)	(55,203)

• 25 - 44	44,242	84,642
Teachers	(11,528)	(6,297)
Technicians & technologists	(32,714)	(78,345)
• 45 - 64	18,453	35,923
Teachers	(5,816)	(4,370)
Technicians & technologists	(12,637)	(31,553)
• 65+	1,457	2,589
Teachers	(688)	(482)
Technicians & technologists	(769)	(2,107)
	1,112,074	1,178,965

- TOTAL = 2,291,339

Problem 3: Eight million lbs/yr of hexamethylenetetramine are produced at Chemical Synthesizers, Sioux Falls, South Dakota. They convert 1 million lbs/yr of that compound to another derivative for sale. How many persons are exposed to the derivative? How many production workers are involved? Characterize by age and sex.

Solution: This problem was solved via application of Methods 3-4 and 3-5 as follows:

Step 1 - Option 2 - Direct enumeration using 1981 South Dakota State Industrial Directory (SIC 2899, Chemical Preparations).

Employment statistics
Office: male = 25 female = 25
Plant: male = 80 female = 46 (Total Plant = 126)

Step 2 - (From text, subsection 3.3.3)

$$\frac{PV_a}{PV_t} = \frac{E_a}{E_t}$$

$$\frac{1 \times 10^6 \text{ lbs/yr}}{8 \times 10^6 \text{ lbs/yr}} = \frac{E_a}{126 \text{ workers}}$$

$$16 = E_a \text{workers}$$

Using Method 3-5, characterize the population

Option 1 - (See Table 15 of text)

- Ages and sexes are derived from the generic percentages of total employed (16) in the "Operatives, Except Transport" occupation class:

Male	Female
16 - 24 (13.8%) = 2	16 - 24 (6.2%) = 1
25 - 44 (26.1%) = 4	25 - 44 (16.1%) = 2
45 - 64 (20.4%) = 3	45 - 64 (15.0%) = 2
65+ (1.4%) = 1	65+ (1.1%) = 0
10	6

Option 2 - State Industrial Directory indicates that there are 80 men and 46 women employed at the plant. The male:female ratio of 80:46, or 1.74 men for each woman, may be used to derive the population characterization by sex. Of the 16 employees exposed, 10 are men and 6 are women. The age distribution above still applies.

Problem 4: Chemical W, a volatile organic compound, is used in the formulation of specialty plastic products. Approximately 200 plants nationwide use chemical W. Because of its high volatility, production workers and non-production workers are exposed to chemical W vapor. OSHA inspection of 5 plants detected chemical W in all areas with the highest concentrations occurring in the production areas, particularly around melt pot and mold pouring points. Following are the site inspection data for the five plants:

Plant	1	2	3	4	5
Plant Consumption of W (lbs/yr)	100	10,000	50	1,500	500
Total number employees	15	70	9	40	125
Production employees	5	20	4	10	50
-Melters and Molders	2	6	2	6	4

Estimate the total number of (1) non-production employees, (2) production employees, and (3) melters and molders exposed to chemical W nationwide. What are the shortcomings in using the site inspection data?

Solution: This problem was solved via application of Method 3-4 as follows:

Option 2 - Extrapolation from sample data.

Step 1 - (Given)

Step 2 -

- Average number of non-production workers: 34
- Average number of production workers: 18
- Average number of melters and molders: 4

Step 3 - (x200 plants)

• Non-production workers	=	6,800
• Production workers	=	3,600
• Melters and Molders	=	800
		11,200 National Total

Comments: Using actual field data that is relevant to the circumstances being assessed is of course the most defensible approach. However, it is difficult to qualify the representativeness of the sample group, i.e., are these plant data representative of all the plants in the field, and is this a large enough sample group?

APPENDIX A-3

POPULATIONS EXPOSED TO CHEMICAL SUBSTANCES VIA THE INGESTION OF FOOD

Problem 1: Lettuce harvested for sale from the State of California has been treated with a chemical substance to reduce the susceptibility to attack by an insect indigenous to this geographic area. Enumerate the population in the United States that may be exposed to this chemical substance as a result of consuming lettuce harvested for sale from California.

Solution: This problem was solved by the application of Method 4-2 as follows:

Step 1 - Determine the percentage of users of lettuce. The best available source of information regarding the percentage of users of lettuce is the 1977-78 household food consumption survey (USDA 1982). This value is reported to be 69.7 percent of the households surveyed.

Step 2 - Calculate the consuming population or the upper range of the exposed population: Assuming that the household survey is representative of the consumption patterns of the total U.S. population, the percentage determined in Step 1 is multiplied by the total U.S. population in 1980 of 226.5 million.

$$.697 \times 226.5 \text{ million} = 157.9 \text{ million}$$

Step 3 - Determine the percentage of the U.S. total lettuce harvested from California. According to the 1974 Census of Agriculture (Bureau of the Census 1978), this value is 72.3 percent.

Step 4 - Calculate the lower limit of the exposed population. Multiply the percentage obtained in Step 3 by the value calculated for the consuming population from Step 2:

.723 x 157.9 million = 114.2 million

The actual exposed population, therefore, is probably between 114.2 million and 157.9 million people.

Problem 2: Irish potatoes harvested for sale from Penobscot County, Maine, have been treated with a chemical substance to reduce their susceptibility to blight. Enumerate the population of the United States that may be exposed to this chemical substance as a result of consuming potatoes harvested for sale from Penobscot County, Maine.

Solution: This problem was also solved via the application of Method 4-2 as follows:

Step 1 - Determine the percentage of users of Irish potatoes. The best available sources of information regarding the percentage of users of Irish (white) potatoes is the 1977-78 household consumption survey (USDA 1982). This value is reported to be 72.8 percent of the households surveyed.

Step 2 - Calculate the consuming population or upper range of the exposed population. The percentage obtained in Step 1 is multiplied by the total U.S. population in 1980 of 226.5 million.

.728 x 226.5 million = 164.9 million

Step 3 - Determine the percentage of the U.S. total represented by Irish potatoes harvested for sale from Penobscot County, Maine. According to the 1978 Census of Agriculture (Bureau of the Census 1982a), the quantity of Irish potatoes harvested for sale in the United States in 1978 (the most recent year for which data are available) is 314,929,746 hundredweight; the quantity harvested for sale in Penobscot County, Maine, is 1,122,414 hundredweight. The percent of the U.S. total of Irish potatoes harvested for sale in Penobscot County, Maine is:

$$\frac{1,122,414}{314,929,746} \times 100 = .36 \text{ percent}$$

Step 4 - Calculate the lower range of the exposed population. Multiply the percentage obtained in Step 3 by the value calculated for the consuming population from Step 2:

.0036 x 164.9 million = 593,600

The population exposed to the chemical substance, therefore, is between 593,600 people and 164.9 million people.

Problem 3: Yogurt produced in the United States is often packaged in plastic containers possibly containing a residual monomer that may leach from the packaging material into the food. Enumerate the U.S. population possibly exposed to this residual monomer as a result of consuming yogurt.

Solution: This problem was solved by the application of Method 4-3 as follows:

Step 1 - Determine the percentage of users of yogurt. The best available source of information regarding the percentage of users of yogurt is Food Consumption: Households in the United States, Spring 1977, (USDA 1982). This value is reported to be 12.5 percent of the households surveyed.

Step 2 - Calculate the consuming population. The percentage determined in Step 1 is multiplied by the total U.S. resident population in 1980 of 226.5 million:

.125 x 226.5 million = 28.3 million

The estimate of 28.3 million persons is the upper limit of the range of the potentially exposed population. To determine the lower limit of the exposed population, the percentage of yogurt packaged in plastic containers would have to be known. This information may be obtained by contacting the trade association that most closely represents packers of foods or dairy products.

Problem 4: A brand name beer is manufactured from spring water known to be contaminated with a chemical substance. Enumerate the U.S. population exposed to this chemical substance as a result of drinking this brand of beer.

Solution: This problem was solved via the application of Method 4-4 as follows:

Step 1 - Determine the number of users of the brand of beer. The number of users of this beer is reported by Simmons Market Research Bureau, Inc. (1977) to be 10,735,000 adults.

Step 2 - Calculate the exposed population. No adjustment is necessary if one assumes that only adults consume beer, since Simmons' data are representative of U.S. residents over the age of 18.

Problem 5: A certain brand of margarine is reported to be contaminated by a solvent used in cleaning process equipment. Enumerate the total population exposed to the solvent as a result of eating this brand of margarine.

Solution: This problem was also solved via the application of Method 4-4. It is based on the use of SMRB data which are currently not available. Data values are assumed according to the SMRB data format in order to demonstrate the method. SMRB data will be available to personnel of EPA-OTS and their contractors in the near future.

Step 1 - Determine the number of buyers. Simmons may report that 18,000,000 female homemakers buy this brand of margarine.

Step 2 - Calculate the exposed population. The sizes of the 18,000,000 households may be distributed as follows:

1 person household	2,000,000 x 1	2,000,000
2 person household	3,000,000 x 2	6,000,000
3-4 person household	8,000,000 x 4	32,000,000
5 or more person household	5,000,000 x 6	30,000,000
18,000,000 (total buyers)	70,000,000 (total consumers)	

Simmons' usage tables (as discussed in Section 5.0 of this report) present data on household size.

Problem 6: The Kanawha River in West Virginia has been contaminated by a chemical substance from an industrial effluent. Enumerate the population exposed as a result of consuming fish caught on a noncommercial basis.

Solution: This problem was solved via application of Method 4-5 as follows:

According to the 1975 West Virginia Fishing Survey, the number of fishermen fishing on the Kanawha River in 1975, the most recent year for which statistics are available, is 9,400. Assuming each fisherman catches and consumes fish, this number represents a lower limit for the actual exposed population. If one assumes that each fisherman represents a consuming household and that there are 2.78 persons per household (Bureau of the Census 1982b), then a rough approximation of the upper limit for the exposed population is 2.78 x 9,400 = 26,132.

Problem 7: A chemical substance is detected in five percent of the processed whole milk samples analyzed. Enumerate the population potentially exposed to the chemical substance.

Solution: This problem was solved via application of Method 4-8 as follows:

Step 1 - The monitoring data identify the contaminated food item as processed whole milk.

Step 2 - The total consuming population can be enumerated by the data presented in Food Consumption: Households in the United States, Spring 1977, (USDA 1982). According to the data for household use in a week, 65.5 percent of the household sampled bought fluid milk. The total consuming population is, therefore, .655 x 226.5 million = 148.4 million.

Step 3 - The frequency of detection is 0.05.

Step 4 - The lower limit of exposed population is
= 0.05 x 148.4 million
= 7.4 million

The population exposed to the chemical substance is between 7.4 million and 148.4 million people.

Problem 8: A contaminant in milk may result in significant risk to children between the ages of 0 and 8 years old. Estimate the exposed population for this age group.

Solution: This problem was solved via application of Method 4-2 and Method 4-9 as follows:

Step 1- According to USDA Household Consumption Survey of 1977-78 (USDA 1982), 65.5 percent of the households surveyed consume milk. The total milk consuming populations is approximated as:

0.655 x 226.5 million = 148.4 million

Step 2- According to the USDA Individual Food Consumption Survey of 1977-78 (USDA 1980) (see Figure 18 of text) 16.98 percent of the milk-consuming population is 8 years old or less. This was calculated by aggregating the consumers of milk for each age class less than 8 years of age and dividing by the total milk consuming population of the sample:

Number of consumers of fluid milk 8 years old or less
= (78 x 0.609) + (264 x 0.905) + (437 x 0.856) + (469 x 0.885)
= 1,076

Number of consumers of fluid milk = 9,620 x 0.659 = 6,340

Percentage of consumers who are 8 years old or less

$$= \frac{1,076}{6,340} \times 100 = 16.97 \text{ percent}$$

The estimated milk consuming population 8 years old or less is:

0.1697 x 148.4 million = 25.2 million

APPENDIX A-4

POPULATIONS EXPOSED TO CHEMICAL SUBSTANCES VIA USE OF CONSUMER PRODUCTS

Problem 1: Chemical X is a solvent used in all aerosol rug cleaners currently marketed.

- How many persons are actively exposed?
- How many persons are exposed at heavy, medium, and light usage levels?
- How many persons are passively exposed?
- Characterize each population above by age and sex distribution.

Solution: This problem was solved via application of Method 5-2 using 1982 SMRB data and Method 5-4 as follows:

Step 1 - Rug cleaners.

Step 2 - SMRB Type tables used (aerosol).

Step 3 - Population actively exposed.

- Due to the inherent bias of the data base, we assume that only female homemakers are actively exposed (data for male counterparts are not available, though men do purchase and use rug cleaners to some extent).

- It is further assumed that use of this product is not restricted to any age group, i.e., that any female homemaker physically capable of applying the product does. Purchase = use = active exposure.

13,862,000 total female homemakers purchase aerosol rug cleaners, of which:

1,746,000 are 18 – 24 years of age, (12.6%);
3,855,000 are 25 – 34 years of age, (27.8%);
2,351,000 are 35 – 44 years of age, (17.0%);
2,232,000 are 45 – 54 years of age, (16.1%);
2,136,000 are 55 – 64 years of age, (15.4%); and
1,543,000 are 65+ years of age, (11.1%).

Step 4 - Since SMRB data are not provided for heavy, medium, and light (H, M, L) users of aerosol rug cleaners, the ratio of H:M:L users of all rug cleaner types is applied. This is derived from the appropriate SMRB data table for rug cleaners (1982 data).

(i) 36,879,000 total female homemakers use all types of rug cleaners of which:
13,063,000 are at heavy levels;
10,034,000 are at medium levels; and
13,783,000 are at light levels.

(ii) H:M:L =
0.35:0.27:0.37 = 1.00

(iii) Applied to the 13,862,000 total aerosol users:
4,852,000 are at heavy levels;
3,743,000 are at medium levels; and
5,129,000 are at light levels.

Step 5 - Population passively exposed.

Option 2

(i) Of the 13,862,000 total aerosol rug cleaner users:
1,566,000 live in single person households;
4,392,000 live in 2 person households;
5,878,000 live in 3-4 person households; and
2,026,000 live in 5 or more person households.

(ii) 1,566,000 x 1 = 1,566,000
4,392,000 x 2 = 8,784,000
5,878,000 x 4 = 23,512,000
2,026,000 x 6 = 12,156,000

Total passively
exposed population = 46,018,000
(men and women)

(iii) Method 5-4, using generic 1980 resident population characteristic data (text Table 12).
Ratio of males to females = 0.49:0.51,
applied to total population passively exposed =
22,548,820 males, of which:

1,711,455 are under 5 years of age (7.59%);
1,749,788 are 5 - 9 years of age (7.76%);
1,907,630 are 10 - 14 years of age (8.46%);
2,203,020 are 15 - 19 years of age (9.77%);
2,184,981 are 20 - 24 years of age (9.69%);
3,765,653 are 25 - 34 years of age (16.70%);
2,575,075 are 35 - 44 years of age (11.42%);
2,254,882 are 45 - 54 years of age (10.00%);
2,079,001 are 55 - 64 years of age (9.22%);
1,384,498 are 65 - 74 years of age (6.14%);
586,269 are 75 - 84 years of age (2.60%); and
139,803 are 85+ years of age (0.62%).

And 23,469,180 females, of which:

1,607,639 are under 5 years of age (6.85%);
1,642,843 are 5 - 9 years of age (7.00%);
1,797,739 are 10 - 14 years of age (7.66%);
2,098,145 are 15 - 19 years of age (8.94%);
2,147,430 are 20 - 24 years of age (9.15%);
3,766,803 are 25 - 34 years of age (16.05%);
2,633,242 are 35 - 44 years of age (11.22%);
2,375,081 are 45 - 54 years of age (10.12%);
2,328,143 are 55 - 64 years of age (9.92%);
1,776,617 are 65 - 74 years of age (7.57%);
978,665 are 75 - 84 years of age (4.17%); and
314,487 are 85+ years of age (1.34%).

Problem 2: A manufacturer submits a PMN for a new type of solvent to be used in rug cleaners. He plans to produce and market 500,000 kg/year.

- How many persons will be exposed, both actively and passively?

- Characterize the active and passive population by age and sex.

Solution: The solution of Problem 2 employs a variation of Method 5-3. The steps outlined below do not exactly match those presented in the method because the multitude of assumptions that must be made and the lack of available data. As was stated in the introduction to this Appendix, the method's primary function is to provide a framework for population enumeration and introduce the tools that can be used. The solution of this problem illustrates the creativity and flexibility that must be applied when utilizing the methods provided.

Actively Exposed Populations

- Gosselin's (1976) Clinical Toxicology of Commercial Products* was used to evaluate "solvents" as formulation components of these products. Because the term "solvent" can be ambiguous if not clearly described, it was assumed that the solvent subject of the PMN must (a) not be water; (b) be present in formulation in a significant proportion; and (c) be a volatile distillate used primarily as a support matrix that would evaporated very quickly immediately following application. Analysis of the information found in Gosselin et al. (1976) produced the following results:

Two types of "solvent" containing cleaners used predominantly for rugs and carpets were identified as:

(1) soap-solvent combination cleaners, that were
  - liquid
  - 15 - 45 (30%) solvent content
  - 45 - 95% water content
  - 0.7 - 5% ammonia content
  - 0 - 2% solids (soaps, borax, etc.)

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*Gosselin RE, Hodge MC, Smith RP, Gleason MN. 1976. Chemical toxicology of commercial products. 4th edition. Baltimore, MD: The Williams and Wilkins Company.

(2) absorbent type cleaners, that were
  - aerosol
  - 25% solvent content, primarily light petroleum distillate
  - 75% solids (as sorbants and propellant)

- Given: Solvent product = 500,000 kg/yr.
  Use: solvent in aerosol and liquid rug cleaners.

	Percent solvent (avg)	wt/unit cleaner (kg)[1]	\$/kg[1]	#purchasers/yr[2]
Aerosol	25%	0.609	5.02	13,862,000
liquid	30%	1.340	3.82	18,939,000
powder	-	0.5435	6.33	6,044,000

---

[1] From Table 33
[2] From SMRB (text, Table 23)

36% of the purchasers purchase aerosols
49% purchase liquids
16% purchase powders

- There are two alternative assumptions which could be made to facilitate estimating the breakdown of the 500,000 kg between aerosol and liquid:

(1) Consumers use equal amounts by weight of each type. Therefore, 36% of the kg of rug cleaner produced is in aerosol form, 49% is liquid (and 16% is powder).

(2) Consumers use equal amounts by unit of each type. Therefore, 36% of the units produced are aerosol, 49% are liquid (and 16% are powder).

ASSUMPTION NO. 1: kg aerosol/person = kg liquid/person.

Step 1 - Determine how much of the 500,000 kg of chemical goes into aerosols and how much goes into liquids.

For every 36 kg of aerosol rug cleaner purchased, 49 kg of liquid are purchased. The aerosol contains 25% by weight of the chemical solvent in question, and the liquid contains 30%.

Table 33. Rug/Carpet Cleaning Products Market Survey Results[1]

Name		Reported weight[2] (kilograms)	Averaged retail price[3] (dollars)	Retail price per kilogram (dollars)
Aerosol Products:	(ounces)			
Scotchgard Carpet Cleaner		0.524	3.19	6.09
Woolite Rug Cleaner		0.624	3.19	5.11
Glamorene Spray'n Vac	(24)	0.680	2.89	4.25
Glory Rug Cleaner (Johnson Wax)	(24)	0.680	2.85	4.19
Lestoil Rug Cleaner (Noxell)	(19)	0.538	2.89	5.37
Carpet Magic Rug Shampoo	(19)	0.538	2.49	4.63
Bissell Foam Rug Cleaner	(24)	0.680	3.75	5.51
Average		0.609		5.02
Liquid Products:	(fluid ounces)			
Scotchgard Carpet Cleaner	(32)	0.946	4.29	4.53
Glamorene Rug Cleaner	(32)	0.946	2.89	3.05
Carpet Magic "steam" Cleaning (solution)	(65.5)	1.937	6.29	3.25
Carpet Magic Rug Shampoo (concentrate)	(64.5)	1.907	5.89	3.09
Bissell Wall to Wall Rug Shampoo	(32)	0.946	4.39	4.64
Trewax Up and Out Rug Shampoo	(46)	1.360	5.89	4.33
Average		1.340		3.82
Powder Products:	(ounces)			
Bissell Powder Carpet Cleaner		0.453	2.89	6.38
Airwick Plush Dry Cleaner	(16)	0.454	2.85	6.28
Average		0.5435		6.33

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[1] Performed by Versar, November 1982.

[2] Conversion of fluid ounces to grams assumed density of water, using the formula:

$$\frac{1\text{ gram}}{1\text{cc}} \times \frac{1000\text{ cc}}{1\text{ liter}} \times \frac{2.957\times10^{-2}}{1\text{ fluid oz.}}\text{ liters} = \frac{29.57\text{ g}}{1\text{ fluid oz.}}$$

[3] Products appearing in several establishments with different prices display an average of those prices.

Thus:

% Total available solvent used in aerosol =

$$\frac{36 \text{ kg aerosol} \times \frac{0.25 \text{ kg solvent}}{\text{kg aerosol}}}{36 \text{ kg aerosol} \times \frac{0.25 \text{ kg solvent}}{\text{kg aerosol}} + 49 \text{ kg liquid} \times \frac{0.30 \text{ kg solvent}}{\text{kg liquid}}} \times 100\%$$

$$= 38\%$$

% Total available solvent used in liquid =

$$\frac{49 \text{ kg liquid} \times \frac{0.30 \text{ kg solvent}}{\text{kg liquid}}}{49 \text{ kg liquid} \times \frac{0.30 \text{ kg solvent}}{\text{kg liquid}} + 36 \text{ kg aerosol} \times \frac{0.25 \text{ kg solvent}}{\text{kg aerosol}}} \times 100\%$$

$$= 62\%$$

Thus,

190,000 kg solvent (500,000 x 38%) will be used in aerosols, and

310,000 kg solvent (500,000 x 62%) will be used in liquids.

Step 2 - Determine the kilograms of both aerosol and liquid products which could be produced from available solvent.

$$\text{kg aerosol product} = \frac{190,000 \text{ kg}}{0.25} = 760,000 \text{ kg } (42\%)$$

$$\text{kg liquid product} = \frac{310,000 \text{ kg}}{0.30} = 1,033,333 \text{ kg } (58\%)$$

This is what would be expected because if 36 kg of aerosol are purchased for every 49 kg of liquid, proportionally, 42% of the purchases would be aerosol and 58% would be liquid.

Step 3 - Determine number of persons actively exposed. Since products are purchased on a unit basis, the kg are converted to units:

$$\frac{760,000 \text{ kg}}{0.609 \text{ kg/unit}} = 1,248,000 \text{ units of aerosol}$$

$$\frac{1{,}033{,}333}{1.34\text{ kg/unit}}\text{ kg} = 771{,}000\text{ units of liquid}$$

If kg aerosol/person = kg liquid/person, then two aerosol units would be used per one liquid unit (2 x 0.609 kg/unit ~ 1.34 kg/unit). The following conclusions can be drawn:

	Possible consumption scenarios (per year) liquid	aerosol	Number actively exposed
(Case 1)	1 unit	2 units	1,395,000 $\left(771{,}000 + \frac{1{,}248{,}000}{2}\right)$
(Case 2)	2 units	4 units	624,000 (1/2 x 1,248,000)
(Case 3)	3 units	6 units	465,000 $\left(\frac{771{,}000}{3} + \frac{1{,}248{,}000}{6}\right)$

ASSUMPTION NO. 2: Units of aerosol/person = units liquid/person

Step 1 - Determine how much of the 500,000 kg goes into aerosols and how much goes into liquids. 36 units of aerosol are produced for every 49 units of liquid. Thus:

% Total available solvent used in aerosol =

$$\frac{36\text{ units aerosol} \times \frac{0.25\text{ kg solvent}}{\text{kg aerosol}} \times \frac{0.609\text{ kg aerosol}}{\text{unit aerosol}}}{36\text{ units aerosol} \times \frac{0.25\text{ kg solvent}}{\text{kg aerosol}} \times \frac{0.609\text{ kg aerosol}}{\text{unit aerosol}} + \left(49\text{ units liquid} \times \frac{0.30\text{ kg solvent}}{\text{kg liquid}} \times \frac{1.34\text{ kg liquid}}{\text{unit liquid}}\right)} \times 100\%$$

$$= 22\%$$

% Total available solvent used in liquid =

$$\frac{49\text{ units liquid} \times \frac{0.30\text{ kg solvent}}{\text{kg liquid}} \times \frac{1.34\text{ kg liquid}}{\text{unit liquid}}}{49\text{ units liquid} \times \frac{0.30\text{ kg solvent}}{\text{kg liquid}} \times \frac{1.34\text{ kg liquid}}{\text{unit liquid}} + 36\text{ units aerosol} \times \frac{0.25\text{ kg solvent}}{\text{kg aerosol}} \times \frac{0.609\text{ kg aerosol}}{\text{unit aerosol}}} \times 100\%$$

$$= 78\%$$

Thus,

110,000 kg solvent (500,000 x 22%) will be used in aerosols, and

390,000 kg solvent (500,000 x 78%) will be used in liquids.

Step 2 - Determine the number of units which can be produced.

$$\text{units aerosol product} = \frac{110{,}000 \text{ kg}}{(25\%)(0.609 \text{ kg/unit})} = 722{,}000 \text{ units } (43\%)$$

$$\text{units liquid product} = \frac{390{,}000 \text{ kg}}{(30\%)(1.34 \text{ kg/unit})} = 970{,}000 \text{ units } (57\%)$$

As with Step 2 of assumption one, approximately 43% and 57% would be what was expected.

Step 3 - Determine the number of persons actively exposed.

If units of aerosol/person = units of liquid/person, then one aerosol unit would be used per one liquid unit. The following conclusions can be drawn:

	Possible consumption scenarios (per year)		
	liquid	aerosol	Number actively exposed
(Case 1)	1	1	1,692,000 (722,000 + 970,000)
(Case 2)	2	2	846,000 (1/2 x 1,692,000)
(Case 3)	3	3	564,000 (1/3 x 1,692,000)

o Without more information on actual personal consumption patterns of these products, neither assumption one nor assumption two provide "more accurate" exposure numbers. So, for the purpose of the continuation of this analysis, a "worst case" value will be adopted to represent exposure for this problem (assumption two, case one = 1,692,000).

Passively Exposed Populations

The enumeration of the population passively exposed to the solvent-containing rug cleaning products is based on the actively exposed population and follows the methods outlined in Step 5 of Method 5-2, with some modification.

Assume that the same percentage of household sizes identified for all rug cleaner users applies to the population enumerated for rug cleaner users. (Actively exposed to the PMN solvent).

(i) From SMRB data; text Table 22.

Household of:	1 person	2 people	3-4 people	5+ people
Percentage:	12.6%	30.8%	40.1%	16.5%

(ii) 1 person household = 1,692,000 x 0.126 x 1 = 213,000
2 person household = 1,692,000 x 0.308 x 2 = 1,042,000
3-4 person household = 1,692,000 x 0.401 x 4 = 2,714,000
5 + person household = 1,692,000 x 0.165 x 6 = 1,675,000

Total passively exposed population = 5,644,000

Characterization of actively and passively exposed populations.

(i) The actively exposed population (100% female) is characterized for age distribution using the SMRB data base. (Text Table 22). These data indicate:

Years of age	Percent of total
18-24	10%
25-34	24%
35-44	19%
45-54	16%
55-64	15%
65+	15%

These percentages applied to the 1,692,000 females actively exposed results in the following:

169,200 are 18-24
406,080 are 25-34
321,480 are 35-44
270,720 are 45-54
253,800 are 55-64
253,800 are 65 or older

(ii) Characterization of the passively exposed population (males and females) relies entirely on generic U.S. Census data (text Table 12). Ratio of males to females = 0.49:0.51. Applied to the total population passively exposed (5,644,000), 2,766,000 are male of which:

210,000 are under 5 years of age (7.59%);
215,000 are 5 - 9 years of age (7.76%);
234,000 are 10 - 14 years of age (8.46%);
270,000 are 15 - 19 years of age (9.77%);
268,000 are 20 - 24 years of age (9.69%);
462,000 are 25 - 34 years of age (16.70%);
316,000 are 35 - 44 years of age (11.42%);
277,000 are 45 - 54 years of age (10.00%);
255,000 are 55 - 64 years of age (9.22%);
170,000 are 65 - 74 years of age (6.14%);
71,900 are 75 - 84 years of age (2.60%); and
17,100 are 85+ years of age (0.62%).

And, 2,878,000 are female of which:

197,000 are under 5 years of age (6.85%);
201,000 are 5 - 9 years of age (7.00%);
220,000 are 10 - 14 years of age (7.66%);
257,000 are 15 - 19 years of age (8.94%);
285,000 are 20 - 24 years of age (9.15%);
462,000 are 25 - 34 years of age (16.05%);
323,000 are 35 - 44 years of age (11.22%);
291,000 are 45 - 54 years of age (10.12%);
285,000 are 55 - 64 years of age (9.92%);
218,000 are 65 - 74 years of age (7.57%);
120,000 are 75 - 84 years of age (4.17%); and
38,600 are 85+ years of age (1.34%).

APPENDIX A-5

POPULATIONS EXPOSED TO CHEMICAL SUBSTANCES VIA INGESTION OF DRINKING WATER

Problem 1: Point Source Surface Water - Chemical Q is discharged from a plant located in Lambertville, NJ (40°22'00" - 74°56'10") to the Delaware River. Surface water monitoring has detected Chemical Q downstream of the plant as far as Wilmington, DE. Enumerate the population potentially exposed to Chemical Q because their drinking water is obtained from the Delaware River. Chemical Q is teratogenic. How many women of child-bearing age are potentially exposed?

Solution: This problem was solved via application of Method 6-2 as follows:

Step 1 - Not applicable

Step 2 - Not applicable

Step 3 - The first step towards solution of this problem was the identification of the USGS cataloging units of concern between Lambertville, NJ and Wilmington, DE. Cataloging units were obtained from USGS Hydrologic Unit Maps for the states of New Jersey, Pennsylvania, and Delaware. The cataloging units are:

02-04-02-05
02-04-02-04
02-04-02-03
02-04-02-02
02-04-02-01
02-04-01-05

The next step was the identification of the downstream and upstream Delaware River REACH numbers between which drinking water intakes are to be identified. REACH numbers were obtained from REACH maps on file at the EPA-Monitoring and Data Support Division, Water Quality Analysis Branch. The cataloging unit and REACH (segment) numbers to which the eventual WSDB retrieval was limited are:

02-04-01-05-006 (Lambertville, NJ)
02-04-02-04-002 (Wilmington, DE)

Step 4 - A hydrologic tree retrieval was requested from the EPA-Monitoring and Data Support Division. The retrieval request was limited to drinking water utilities on the Delaware River mainstem as stored in WSDB between the above listed cataloging units. Figure 23 is the output received. Listed below are the utilities and the exposed population (i.e., population served);

```
STORET RETRIEVAL DATE 830406     HYDROLOGICAL TREE   PAGE WIDTH=  154.33 MILES OR   11.69 MILES/INCH

                                                                                                                  D
                                                                                                                  D
                                                                                                                  D
                                                                                                        D         D
                                                                                                D     D D     D   D
*---A-A-----AA--A--------A---A--A-----A--*--A---A---------A----A-A-A-A*A---A-A--A--A----A--AA--A*-R--R--------R---*----------
                                                                                                D     D D     D   D
                                                                                                        D         D
                                                                                                                  D
                                                                                                                  D

. ............. . . .
......................
.DELAWARE BAY        .     ** FIRST REACH OF THIS LEVEL IS DOWNSTREAM LIMIT OF RETRIEVAL **
>>>>>>>>>>>>>>>>>>>>>>


RCH  MILE
W  109.48 DRINK PA1510004 PHILADELPHIA WATER D POP 1950098   367700 TGD TYPE P1     TORRESDALE TRMT PLT  SOURCE ?
A  109.48 DRINK PA1510004 PHILADELPHIA WATER D POP 1950098      368 TGD TYPE P1I1   DELAWARE RIVER       SOURCE S
R  117.22 DRINK PA1090001 BRISTOL BOROUGH WATE POP   30000     5200 TGD TYPE P1     BRISTOL TREATMT PLT  SOURCE ?
R  117.22 DRINK PA1090001 BRISTOL BOROUGH WATE POP   30000        5 TGD TYPE P1I1   DELAWARE RIVER       SOURCE S
R  119.28 DRINK PA1090026 LOWER BUCKS JOINT MU POP   90000        0 TGD TYPE P1     LEVITTOWN TRTMT PLT  SOURCE ?
R  119.28 DRINK PA1090026 LOWER BUCKS JOINT MU POP   90000        0 TGD TYPE P1I1   DELAWARE RIVER       SOURCE S
R  119.28 DRINK ?         US STEEL CORP        POP    8000       -1 TGD TYPE P1     TREATMENT PLANT      SOURCE ?
R  119.28 DRINK ?         US STEEL CORP        POP    8000       -1 TGD TYPE P1I1    DELAWARE R          SOURCE S
R  125.80 DRINK PA1090037 MORRISVILLE WATER FI POP   21000     3000 TGD TYPE P1     TREATMENT PLANT      SOURCE ?
R  125.80 DRINK PA1090037 MORRISVILLE WATER FI POP   21000        3 TGD TYPE P1I1    DELAWARE RIVER      SOURCE S
R  131.51 DRINK NJ1017001 LAMBERTVILLE WATER C POP    4400      270 TGD TYPE P1     TREATMENT PLANT      SOURCE ?
R  131.51 DRINK NJ1017001 LAMBERTVILLE WATER C POP    4400        0 TGD TYPE P1I1   SWAN CREEK           SOURCE S
R  131.51 DRINK NJ1017001 LAMBERTVILLE WATER C POP    4400        0 TGD TYPE P1I2   DELAW-RARITAN CANAL  SOURCE S
R  131.51 DRINK NJ1110007 TRENTON WATER DEPT   POP  250000    41000 TGD TYPE P1     MAIN TREATMENT PLNT  SOURCE ?
R  131.51 DRINK NJ1110007 TRENTON WATER DEPT   POP  250000       41 TGD TYPE P1I1   DELAWARE RIVER #1    SOURCE S
R  131.51 DRINK NJ1110007 TRENTON WATER DEPT   POP  250000        0 TGD TYPE P2     RECHLORINATION PLNT  SOURCE ?
R  131.51 DRINK NJ1110007 TRENTON WATER DEPT   POP  250000        0 TGD TYPE P2I1                        SOURCE S
R  131.51 DRINK PA1090074 KEYSTONE WAT-YARD    POP    2616       -1 TGD TYPE P1     TREATMENT PLANT      SOURCE ?
R  131.51 DRINK PA1090074 KEYSTONE WAT-YARD    POP    2616       -1 TGD TYPE P1I1   DELAWARE RIVER       SOURCE S
```

Figure 23. "Hydro Tree" Retrieval for Delaware River Mainstem Between Lambertville, NJ, and Wilmington, DE.

Facility	Exposed Population
Philadelphia Water Dept.	1,950,098
Bristol Water Dept.	30,000
Lower Bucks Water Dept.	90,000
U.S. Steel Water Dept.	8,000
Morrisville Water Dept.	21,000
Lambertville Water Dept.	4,400
Trenton Water Dept.	250,000
Keystone Water Dept.	2,616
Total	2,356,114

"Child-bearing age" is taken as 15 to 44 years of age. The percentage of the U.S. population that is female and within that age group was calculated from Table 12 of the text. Results are as follows:

Age Group	Percent of Total U.S. Population
15-19	4.60
20-24	4.70
25-34	8.25
35-44	5.77
Total	23.32

2,356,114 x 0.2332 = 549,446

Therefore, 549,446 women of child-bearing age are potentially exposed to Chemical Q.

Problem 2: Point Source Ground Water - A waste disposal site on the outskirts of Miami, FL, leaches Chemical K to ground water. Monitoring data has detected K in ground water in all directions up to 50 miles from the site. Enumerate the population potentially exposed to K via drinking water from public and private ground water systems in this area.

Solution: The solution to this problem is based on a slight modification of Method 6-4.

Step 1 - The first step was the identification of the counties around Miami affected by the ground water contamination. This was accomplished by the use of a 1° x 2° topographic map of the Miami area. The 50-mile radius of the waste disposal site basically includes all of Dade County, Florida.

Step 2 - An FRDS retrieval restricted to drinking water utilities in Dade County was requested from the computer system staff of the EPA-Office of Drinking Water. The FRDS retrieval revealed a complex web of public, private, industrial, and business facilities which use ground water for drinking purposes. A total of 472 systems were listed with the major one being the Miami - Dade County Water and Sewer Authority which serves 500,000 people. A sample of an FRDS printout for this system is presented in Figure 24. Only one surface water utility serving 9,037 people, however, was listed. It was felt, therefore, that a more accurate enumeration of the exposed population would be obtained by obtaining the current population of Dade County. This avoids counting any populations twice and also includes those people who have private wells in their home. According to the Census publication, Number of Inhabitants (1980), the total population of Dade County, in which Miami is located, is 1,625,781. This is also the population potentially exposed to the chemical substance. That population which consumes surface supplied drinking water is insignificant; it is also highly probable that they consume ground supplied drinking water at the place of work or other business concerns.

Problem 3: Treatment Method Example - An industrial plant located in Cincinnati, OH, discharges a non-toxic substance to the Ohio River. This substance, however, reacts with flourine to produce a toxic chemical. The non-toxic substance has been detected in the Ohio River 100 miles downstream of the plant. Enumerate the population which consumes flouridated drinking water obtained from the Ohio River and is potentially exposed to the toxic chemical formed.

Solution: This problem was solved by using a combination of Method 6-2 (as in Problem 1) and a modification of the approach discussed in Section 6.3.2 of the text.

Step 1 - The cataloging units and REACH numbers of the inclusive section of the Ohio River 100 miles downstream of Cincinnati were identified from USGS hydrologic unit maps of Ohio and Kentucky and REACH maps on file at the EPA-Monitoring and Data Support Division. The upstream and downstream cataloging units and REACH numbers are as follows:

05-14-02-06-001 (100 miles downstream)
05-09-02-01-001 (Cincinnati)

```
                                                    FEDERAL REPORTING DATA SYSTEM
05/12/82                                    PUBLIC WATER SYSTEM - COMPREHENSIVE REPORT                                   FY    1981
FRDS01                                                                                                                 PAGE     311

EPA REGION: 04  SURVEILLANCE STATE:  FL  PRIMACY:  Y  PWS-ID:  4130871

                   NAME: MIAMI-DADE WATER & SEWER AUTH.          PHONE: (305) 665-7471              INDIAN RESERVATION CODE:
          PLANT ADDRESS: PO BOX 330316                           PLANT AREA LOCATION:               COMPLIANCE CYCLE       : 01
                         MIAMI                        FL 33133     CITY          :                  POSTAL CODE            : FL
           MAILING NAME: MDWASA - MAIN SYSTEM                      COUNTY        : 013              PLANT TYPE             : C
        MAILING ADDRESS: PO BOX 330316                             ADMIN REGION  : 04               OWNER TYPE             : M
                         MIAMI                        FL 33133     ADMIN DISTRICT:

PLANT SERVICE AREA:
   RESIDENTIAL: Y  COMPANY TOWN:    RECREATION  :    MOBILE HOMES  :    INSTITUTION  :    SCHOOL :    OTHER AREA:
   MOTEL      :    RESTAURANT  :    SERV STATION:    CAMPGROUND    :    PICNIC AREA  :    LODGE  :
   MARINA     :    SKI RESORT  :    BATHING     :    VISITOR CENTER:    HWY REST AREA:    AIRPORT:

   ACTIVE INDICATOR    : A          INITIAL DATE       : 02/10/79   BEGIN DATE      : 02/01/78     CONSECUTIVE INDICATOR: 0
   POPULATION SERVED   :    500000  NUMBER OF SERVICES:    113435   NUMBER OF METERS:     72753     # OF CONSECUTIVE PWS :
   DESIGN CAPACITY     :          0 EMERGENCY POWER   :  100000000 STORAGE CAPACITY:   2000000     MAXIMUN PRODUCTION    :  126000000
   INTERSTATE CARRIER  : N          AVERAGE PRODUCTION:   84000000 LAST SURVEY DATE:   /  /        LAST UPDATE DATE      : 03/09/81
   DEACTIVATION REASON:             DEACTIVATION DATE :   /  /      MANUAL FILE     :              REGULATE BY           : B

STATE DISCRETIONARY DATA:
   BACTERIOLOGICAL FLG: S   MINIMUN NUMBER DAILY CHECKS:      NON-COMMUNITY SAMPLING FREQ:   0  SEASON:
   CONTINCY MONITORING :    SAMPLES PER QUARTER        :   0  MCL HALT CHECK SAMPLE      :        START: 00/00
   CHLORINE            :    TURBIDITY FLAG             : L    TURBIDITY LIMIT            :        END  : 00/00

CHEMICAL:                                                                                LAB DATA:
  ORGANIC BEGIN PERIOD:  /      ORGANIC END PERIOD:    /      # OF TTHS SAMPLES:    0      LAB TYPE    : BACT   PHYS   INORG   ORG   RAD
  AIR TEMPERATURE     :81.0     NITRATE FREQUENCY :           # OF PLANTS      :   0       LAB CONTROL: N      N      N       N     N
                                                              TIMS SAMPLE FREQ :

RADIOACTIVE:
   FLAG: 4  MONITORING : 3  BETA FREQUENCY MONTHS:     MONITOR GROSS ALPHA:     MONITOR RADIUM MONTHS :
   GROUND WATER MONITOR:    NO. SAMPLES PER YEAR :     NUCLEAR FACILITY   : N   NUCLEAR FACILITY TYPES:
   FACILITY CONTAMINANT ID:
   SAMPLING FREQUENCY     :

SOURCE AND/OR ENTRY POINT INFORMATION:                                                                                  TREATMENTS
(SRC)              (EPT)                                                                                  A P C S F C S T I A F D U R R R
                                                                                     ENTRY                E R O E I O O A R M L I I E E E
                                                      # OF          BASIN   SELLER   POINT   TURB   TURB  R E A D L R F S O M A S H S S S
TYPE  NAME                 CODE  LATITUDE   LONGITUDE  WELLS  AVAIL   #       ID      ID     FLAG   UNITS A C G I T R T T N U D I R 1 2 3

SRC   FLI                  G      254218     802014       -   P                                           Y Y Y Y Y   Y   Y   Y Y
```

Figure 24. Sample FRDS Retrieval for the Miami-Dade Water & Sewer Authority

Step 2- A hydrologic tree retrieval restricted to water supplies on the Ohio River between these river segments was requested from the EPA-Monitoring and Data Support Division, Water Quality Analysis Branch. The output is similar to Figure 23, previously presented. The purpose of this retrieval was twofold (1) to identify utilities and (2) to obtain the FRDS number of the utilities identified. The FRDS number would then be used to retrieve treatment information for those facilities from the FRDS Data Base of the EPA-office of Drinking Water. The retrieval, however, revealed that only three facilities withdraw drinking water from the Ohio River within 100 miles downstream of Cincinnati. These are the Newport Water Works, the Cincinnati Water Department, and the Kenton County Water Works. Since so few facilities are involved, it was decided to call each individually instead of conducting an additional retrieval. They were each contacted; each indicated that they do fluoridate their water. Therefore, the population exposed to the toxic reaction product is the total population served by the three facilities. This was calculated from the retrieval data as follows:

Newport Water Dept.	30,000
Cincinnati Water Dept.	850,000
Kenton Water Dept.	52,000
Total	930,000 persons potentially exposed

Problem 4: Monitoring Example - Chemical S is ubiquitous. As a result of nationwide sampling of both finished surface and ground obtained drinking water at over 100 plants, the following detection frequency is observed.

Concentration	Cumulative detection frequency in finished surface water	Cumulative detection frequency in finished groundwater
≤ 10 ug/l	10%	1%
≤ 5 ug/l	50%	25%
≤ 1 ug/l	95%	50%

Enumerate the population exposed to chemical S at the three concentrations.

Solution: This problem was solved using a combination of the data in Table 29 and Method 6-6.

Step 1 - The first step was the calculation of the relative percent of use of surface and ground water in the U.S. This was accomplished as follows:

From Table 29:

Population consuming surface water = 124,480,000
Population consuming ground water = 87,404,000

It is assumed, since the data in Table 29 do not include systems of fewer than 25 people, that the difference between the current U.S. population (226,504,000) and the total of the above is the population which consumes water from private wells (14,620,000). This population is included in that population which consumes ground water. Therefore, the relative use of ground and surface water is as follows:

$$\text{Surface} = \frac{124,480,000}{226,504,000} = 0.55$$

$$\text{Ground} = \frac{87,404,000 + 14,620,000}{226,504,000} = 0.45$$

Therefore, the populations exposed to different concentrations of S are as follows:

Concentration	Detection frequency Surface	Detection frequency Ground	Fraction of U.S. population[a]	Number of persons ($\times 10^6$)[b]
10	.1	.01	0.060	13.6
5	.5	.25	0.388	87.9
1	.95	.50	0.748	169.4

[a] (surface frequency x 0.55) + (ground frequency x 0.45)

[b] fraction x 226.5 million (1980 U.S. population)

Problem 5: Source Type. A pollutant is detected in five percent of surface water supplies and 50 percent of ground water supplies. Enumerate the potentially exposed population.

Solution: This problem was solved via application of Method 6-6 and the data in Table 29 of the text as follows:

Frequency of detection in surface water = 0.05
Population served by surface water = 124,480,000
Frequency of detection in ground water = 0.50
Population served by ground water = 87,404,000
Population exposed = (0.05)(124,480,000) +(0.50)(87,404,000)
= 49,926,000 persons

Problem 6: System size. A pollutant is detected in 20 percent of finished waters serving fewer than 10,000 persons, but in 70 percent of those serving over 10,000 persons. Enumerate the potentially exposed population.

Solution: This problem was also solved via application of Method 6-6 and the data in Table 29 as follows:

Frequency of detection in "small" systems = 0.20
Population served by "small" systems = 44,182,000
Frequency of detection in "large" systems = 0.70
Population served by "large" systems = 167,702,000
Population exposed = (0.20)(44,182,000) + (0.70)(167,702,000)
= 126,228,000 persons

APPENDIX B

EXAMPLES OF DATA BASES USED IN OCCUPATIONAL POPULATIONS METHODS SECTION

Appendix B. Examples of Data Bases Used in Occupational Population Methods Section

(1) 1970 Census of Population: Occupation by Industry

- Sample of Table 1. Industry group of employed persons by occupation, age, and sex: 1970.

(2) The National Industry - Occupation Employment Matrix, 1970, 1978, and Projected 1990. Volume I.

- Sample of Table 1. Percent distribution of industry employment by occupation, 1970, 1978, and projected 1990.

(3) The National Industry - Occupation Employment Matrix, 1970, 1978, and Projected 1990. Volume II.

- Sample of Table 2. Percent distribution of occupational employment by industry, 1970, 1978, and projected 1990.

- Sample of Table 3. National nonagricultural employment of wage and salary workers by industry, 1970 and projected 1990.

- Sample of Table 4. Total national employment by industry, 1970, 1978, and projected 1990.

- Sample of Table 5. National 1978 employment, projected 1990 requirements, and average annual openings, 1978-90, by occupation.

(4) Employment and Earnings. October 1981.

- Sample of Table B-2. Employees on nonagricultural payrolls by industry.

(5) Example of 1977 Economic Census Reports - 1977 Census of Manufactures: Industry Series. Industrial Organic Chemicals. SIC 2861, 2865, and 2869.

- Samples of tables containing employment information.

(6) Procedures used to Develop the 1978, 1979, 1980 and Projected 1990 OES Survey - Based Matrix

A UNITED STATES
DEPARTMENT OF
COMMERCE
PUBLICATION

PC(2)-7C

SUBJECT REPORTS

Occupation by Industry

1970 CENSUS OF POPULATION

U S DEPARTMENT
OF COMMERCE
Social and Economic
Statistics Administration

BUREAU OF
THE CENSUS

Table 1. Industry Group of Employed Persons by Occupation, Age, and Sex: 1970

[Data based on 5 percent sample see text For meaning of symbols, see text]

United States	Total	Agriculture, forestry, and fisheries	Mining	Construction		Manufacturing									
				Total	Special trade contractors	Total	Lumber and wood products, except furniture	Furniture and fixtures	Stone, clay, and glass products	Primary ferrous industries	Primary nonferrous industries	Fabricated metal industries (including not specified metal)	Machinery, except electrical	Electrical machinery, equipment, and supplies	Motor vehicles and motor vehicle equipment
PERSONS 16 YEARS OLD AND OVER															
Male, employed	**47 730 661**	**2 537 907**	**585 060**	**4 364 281**	**1 786 546**	**14 185 558**	**497 482**	**308 787**	**473 519**	**819 961**	**294 735**	**945 119**	**1 662 489**	**1 193 845**	**902 788**
Professional, technical, and kindred workers	**6 875 878**	**74 788**	**64 909**	**196 302**	**26 917**	**1 776 620**	**11 210**	**10 879**	**34 615**	**52 766**	**26 449**	**77 887**	**256 046**	**327 170**	**79 792**
Accountants	531 518	1 233	8 906	13 420	2 862	138 840	2 066	1 777	4 388	5 887	3 276	8 994	17 564	18 457	8 619
Architects	54 194	4 844	42	2 533	139	2 114	82	19	54	–	19	74	216	108	200
Computer specialists	209 018	229	2 248	1 699	220	81 995	229	287	958	1 611	963	2 236	26 894	13 502	3 373
Engineers	1 213 071	3 813	19 133	97 915	12 956	662 777	2 497	2 658	11 177	16 916	9 832	29 104	104 821	158 884	32 378
Aeronautical and astronautical	67 235	–	–	38	–	58 146	–	156	21	–	–	63	183	1 098	79
Chemical	53 170	21	1 211	1 065	42	42 700	57	38	1 134	676	395	452	1 408	1 652	535
Civil	173 775	1 973	1 082	74 073	4 783	15 127	261	42	948	1 402	216	1 694	1 266	756	462
Electrical and electronic	280 429	188	814	6 264	3 018	154 941	379	22	514	1 486	1 226	1 688	16 716	93 458	1 521
Industrial	185 389	230	1 013	3 225	480	131 382	620	1 164	3 132	5 261	2 668	7 084	19 565	25 305	9 361
Mechanical	179 457	328	1 620	6 249	1 889	120 542	320	199	1 266	1 925	1 491	7 117	31 944	14 289	15 906
Other engineers	273 616	1 073	13 393	7 001	2 744	139 939	860	1 037	4 162	6 166	3 836	11 006	33 739	22 326	4 514
Lawyers and judges	263 506	35	1 110	649	27	8 482	69	–	92	423	155	229	836	1 269	500
Librarians archivists, and curators	27 323	–	28	56	–	865	–	–	44	19	–	–	101	81	–
Mathematical specialists	23 515	94	140	187	–	5 393	–	–	46	166	113	38	556	646	586
Life and physical scientists	178 869	3 687	15 014	1 355	122	75 877	261	38	2 161	5 275	2 003	1 800	3 097	3 492	1 030
Chemists	97 166	179	2 884	407	64	64 330	222	38	1 887	5 255	1 808	1 645	2 387	1 904	965
Operations and systems researchers and analysts	71 787	41	376	528	80	43 928	149	227	875	1 627	638	1 836	6 565	6 716	2 410
Personnel and labor relations workers	200 950	732	1 827	3 410	738	68 103	875	1 153	1 668	2 965	1 234	3 957	8 822	9 508	5 155
Physicians, dentists, and related practitioners	494 779	15 485	80	119	19	2 502	23	–	40	103	–	62	154	233	180
Dentists	89 800	–	39	19	–	157	–	–	22	–	–	–	15	60	–
Pharmacists	97 181	–	21	41	–	601	–	–	–	–	–	–	–	–	–
Physicians, medical and osteopathic	254 854	84	20	–	–	1 403	23	–	18	103	–	62	122	173	180
Other related practitioners	52 944	15 401	–	59	19	341	–	–	–	–	–	–	17	–	–
Registered nurses, dietitians, and therapists	52 610	239	26	75	17	702	30	–	–	47	20	–	32	22	65
Health technologists and technicians	79 189	282	82	118	19	3 302	–	16	42	19	–	22	42	130	–
Religious workers	231 270	19	–	20	–	153	–	–	–	–	–	–	33	22	–
Social scientists	89 508	143	528	497	22	24 509	124	85	499	749	387	728	4 208	3 546	1 580
Social and recreation workers	111 050	189	–	94	–	565	–	–	–	44	–	–	44	84	18
Teachers, college and university	352 429	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Teachers, except college and university	813 269	149	69	324	79	7 999	21	167	80	276	52	332	1 908	1 174	371
Engineering and science technicians	731 409	6 520	10 761	53 477	6 268	378 426	1 828	2 504	8 634	14 235	6 472	23 101	59 456	85 914	16 776
Draftsmen	268 562	1 155	3 094	21 852	4 758	136 830	1 199	2 174	2 621	4 815	1 768	16 502	34 282	26 568	9 415
Electrical and electronic engineering technicians	150 934	72	733	1 844	1 048	81 085	113	46	443	570	304	678	11 316	47 022	827
Industrial and mechanical engineering technicians	31 845	–	71	205	36	27 430	38	129	621	2 428	468	927	3 984	3 533	3 580
Other engineering and science technicians	280 068	5 293	6 863	29 576	426	133 081	478	155	4 949	6 422	3 932	4 994	9 874	8 791	2 954
Technicians, exc. health, and eng. and science	139 820	3 034	1 510	2 520	408	11 571	133	24	250	248	209	348	1 699	925	104
Airplane pilots	51 374	2 320	461	519	119	3 365	114	24	98	105	61	132	169	266	–
Embalmers	4 759	–	–	–	–	43	–	–	–	–	21	–	–	–	–
Radio operators and air traffic controllers	44 700	187	96	774	69	645	19	–	42	44	–	–	21	76	–
Other technicians, exc health, and eng and science	38 987	527	953	1 227	220	7 518	–	–	110	99	127	216	1 509	583	104
Writers, artists, and entertainers	531 785	8 117	808	6 825	1 771	166 415	394	1 664	2 305	1 206	528	3 089	15 194	17 881	5 308
Other professional, technical, and kindred workers	475 009	25 903	2 221	10 481	1 170	92 102	2 429	260	1 302	950	548	1 937	3 804	4 576	1 139
Managers and administrators, except farm	**5 325 901**	**22 080**	**38 267**	**422 282**	**135 489**	**967 934**	**31 929**	**20 729**	**34 792**	**21 599**	**13 575**	**67 442**	**117 773**	**95 042**	**26 251**
Buyers, purchasing agents, and sales managers	692 492	1 476	6 049	13 359	4 266	198 521	4 103	4 131	5 312	4 852	2 746	13 313	26 358	22 218	6 345
Other managers and administrators	4 633 409	20 604	32 218	408 923	131 223	769 413	27 826	16 598	29 480	16 747	10 829	54 129	91 415	72 824	19 906
Salaried	3 716 865	12 021	25 857	263 370	78 391	704 858	17 500	14 627	26 750	16 307	10 395	49 416	84 965	71 385	19 346
Self-employed	916 544	8 583	6 361	145 553	52 832	64 555	10 326	1 971	2 730	440	434	4 713	6 450	1 439	560
Sales workers	**3 290 269**	**8 702**	**4 669**	**30 656**	**13 968**	**477 859**	**5 822**	**10 314**	**13 340**	**7 244**	**4 640**	**22 293**	**45 739**	**23 424**	**8 312**
Newsboys	53 733	–	–	–	–	48 812	–	–	–	–	–	–	–	–	–
Other specified sales workers	918 113	901	161	3 312	1 242	50 388	155	176	345	400	174	673	1 451	1 125	498
Salesmen and sales clerks, n.e.c.	2 318 423	7 801	4 508	27 344	12 726	378 659	5 667	10 138	12 995	6 844	4 466	21 620	44 288	22 299	7 814

Table 1. Industry Group of Employed Persons by Occupation, Age, and Sex: 1970 – Continued

[Data based on 5 percent sample see text For meaning of symbols see text]

United States	Total	Agriculture, forestry and fisheries	Mining	Construction		Manufacturing									
				Total	Special trade contractors	Total	Lumber and wood products, except furniture	Furniture and fixtures	Stone, clay, and glass products	Primary ferrous industries	Primary nonferrous industries	Fabricated metal industries (including not specified metal)	Machinery, except electrical	Electrical machinery, equipment, and supplies	Motor vehicles and motor vehicle equipment
PERSONS 16 YEARS OLD AND OVER – Continued															
Male, employed – Continued															
Clerical and kindred workers	**3 632 956**	**10 381**	**23 222**	**102 377**	**37 418**	**915 152**	**11 578**	**15 028**	**23 426**	**55 028**	**16 640**	**59 144**	**110 743**	**88 005**	**56 118**
Bookkeepers	278 213	2 658	4 301	15 543	5 584	63 768	1 503	1 135	2 400	3 386	1 413	4 312	7 196	5 610	3 934
Cashiers	132 575	133	88	336	157	2 043	20	–	59	130	–	123	123	203	83
Estimators and investigators, n e c	163 496	831	1 166	34 622	18 503	31 135	511	522	722	1 416	300	4 139	4 121	2 946	1 465
Office machine operators	149 103	335	1 886	1 275	255	47 366	399	352	823	1 836	705	2 147	7 526	5 475	2 939
Secretaries, stenographers, and typists	128 256	519	877	4 258	1 347	24 816	403	391	506	1 738	507	1 730	2 685	1 999	1 803
Shipping and receiving clerks	353 729	704	796	2 920	1 383	192 883	3 004	6 406	4 719	8 861	3 971	16 584	19 742	15 254	8 835
Stock clerks and storekeepers	351 589	734	2 996	5 446	1 874	137 251	1 187	2 069	3 186	6 016	2 598	8 750	23 190	17 191	14 127
Other clerical and kindred workers	2 075 995	4 467	11 112	37 977	8 315	415 890	4 551	4 153	11 011	31 645	7 146	21 359	46 160	39 327	22 932
Craftsmen and kindred workers	**10 121 156**	**43 101**	**157 808**	**2 576 630**	**1 307 378**	**3 636 269**	**88 441**	**97 384**	**103 447**	**285 826**	**82 029**	**264 409**	**456 381**	**250 891**	**227 932**
Construction craftsmen	2 775 379	14 686	42 883	1 898 616	1 079 159	412 584	21 994	12 786	17 699	43 321	11 052	33 574	28 817	23 132	27 397
Brickmasons and stonemasons	163 188	497	550	142 236	88 452	13 448	67	–	1 756	7 254	614	1 122	528	260	410
Carpenters	841 024	5 458	7 262	640 783	217 172	87 253	9 497	9 954	2 528	3 986	1 615	3 839	3 729	2 701	2 255
Electricians	472 332	421	10 723	211 753	193 828	141 592	2 211	475	4 676	16 403	5 584	7 561	12 525	13 458	12 306
Excavating, grading and road machine operators	312 617	6 098	20 512	223 395	31 142	29 101	8 844	233	4 560	4 716	707	1 059	1 325	155	698
Painters (const & maint), plasterers & paperhangers	355 583	941	993	242 157	215 639	38 761	591	1 907	564	924	456	2 997	4 157	2 993	4 053
Plumbers and pipefitters	380 311	787	2 249	233 768	193 649	76 547	571	130	1 725	7 341	1 918	3 954	5 427	3 177	7 257
Other construction craftsmen	250 324	484	594	204 524	139 277	25 882	213	87	1 890	2 697	158	13 042	1 126	388	418
Foremen, n e c	1 444 526	10 757	40 375	151 960	45 987	839 034	22 287	20 971	32 992	55 246	22 614	62 942	87 132	74 385	50 879
Mechanics and repairmen	2 409 844	9 657	34 117	118 216	63 173	614 194	10 135	5 823	24 379	30 545	11 940	29 505	75 585	45 483	59 807
Automobile, including body	909 694	2 299	4 171	15 148	2 208	65 589	1 759	108	3 774	1 360	518	1 393	2 857	1 242	37 260
Metal craftsmen, except mechanics	1 068 311	1 382	5 906	76 956	60 141	884 116	8 395	5 456	12 833	90 470	27 346	116 303	242 630	77 012	76 607
Machinists job setters, and toolmakers	649 148	683	3 988	4 761	1 576	584 770	2 748	3 879	9 393	22 792	14 279	66 815	205 417	58 903	54 495
Blacksmiths, forgemen hammermen, boilermakers	54 772	243	878	5 949	2 443	31 345	197	116	369	7 171	1 064	9 828	2 510	439	1 285
Other metal craftsmen	364 391	456	1 040	66 246	56 122	268 001	5 450	1 461	3 071	60 507	12 003	39 660	34 703	17 670	20 827
Printing craftsmen	333 117	86	206	1 928	746	303 371	200	334	474	875	191	2 758	2 151	2 092	529
Stationary engineers and power station operators	189 249	408	18 385	4 731	1 492	51 695	756	320	1 435	5 025	1 314	1 847	3 637	2 993	2 159
Other craftsmen and kindred workers	1 900 730	6 125	15 936	324 223	56 680	531 275	24 674	51 694	13 635	60 344	7 572	17 480	16 429	25 794	10 554
Operatives, except transport	**6 480 089**	**20 414**	**216 297**	**224 583**	**109 241**	**4 626 788**	**154 911**	**123 319**	**152 454**	**259 822**	**115 315**	**364 514**	**578 644**	**336 714**	**410 160**
Assemblers	484 066	390	468	2 422	1 122	463 208	7 690	22 920	3 790	4 702	2 508	30 308	93 412	74 227	127 954
Checkers, examiners, and inspectors manufacturing	360 105	–	–	–	–	360 105	2 738	4 418	10 527	17 401	9 325	22 770	51 593	57 629	49 234
Filers, polishers sanders and buffers	92 884	140	245	609	419	81 899	5 626	11 546	4 271	2 044	2 980	13 290	8 701	4 036	10 768
Painters manufactured articles	99 041	81	207	19	19	75 186	1 516	8 710	1 346	2 289	995	8 129	9 961	8 091	13 225
Precision machine operatives	376 508	436	1 523	2 465	817	358 504	3 980	5 045	4 650	27 780	6 355	36 898	153 629	25 655	37 930
Drill press operatives	55 770	63	267	353	70	53 534	344	709	755	1 733	861	5 742	23 045	5 592	5 377
Grinding machine operatives	125 189	112	656	301	80	119 173	620	271	1 173	17 254	3 445	12 698	47 559	6 096	16 075
Lathe and milling machine operatives	131 611	142	396	1 411	606	124 836	2 371	1 786	2 309	7 175	1 664	10 181	54 313	9 621	9 912
Precision machine operatives, n e c	63 938	119	204	400	61	60 961	645	2 279	413	1 618	385	8 277	28 712	4 346	6 566
Punch and stamping press operatives	114 990	165	85	950	498	110 951	499	2 232	1 202	6 567	3 559	27 860	18 619	16 146	23 205
Solderers	6 788	–	–	107	63	5 967	–	57	132	86	86	510	755	1 864	1 011
Stationary firemen	90 106	534	1 055	1 050	284	47 473	4 246	1 089	8 028	3 092	1 629	1 196	1 396	1 490	1 350
Welders and flame cutters	512 921	2 458	10 989	61 927	26 546	346 573	2 151	6 202	6 724	30 168	5 342	72 303	73 922	20 772	48 631
Other specified operatives	2 538 222	6 615	201 308	121 624	69 451	1 264 285	65 360	25 830	30 685	60 513	25 956	46 577	39 745	35 582	23 461
Machine operatives, miscellaneous specified	738 305	4 549	167	9 140	2 579	659 226	24 287	14 420	37 208	40 586	28 586	39 414	35 799	30 763	22 732
Machine operatives, not specified	407 172	1 318	39	5 786	1 084	366 399	9 897	8 050	14 232	17 916	12 436	33 269	55 196	24 101	28 535
Miscellaneous operatives	444 699	2 063	22	13 572	3 700	306 948	13 511	9 090	18 484	27 052	10 364	19 261	21 968	24 259	13 683
Not specified operatives	214 282	1 665	189	4 912	2 659	180 064	13 410	3 710	11 175	19 626	5 194	12 729	13 948	12 099	8 441
Transport equipment operatives	**2 821 034**	**28 490**	**45 547**	**174 656**	**28 811**	**596 183**	**45 644**	**10 478**	**54 166**	**26 266**	**12 083**	**28 773**	**27 294**	**17 127**	**31 814**
Deliverymen and routemen	591 866	4 472	1 689	6 636	3 272	137 612	1 789	1 950	4 593	1 049	483	2 614	2 600	1 757	1 275
Fork lift and tow motor operatives	214 062	1 106	1 601	5 476	1 696	154 492	14 353	2 369	11 368	8 653	6 060	11 843	11 971	7 881	15 523
Truck drivers	1 369 678	20 212	32 648	144 151	22 717	247 817	28 799	5 965	37 102	10 647	4 864	12 774	11 198	5 979	10 930
Other transport equipment operatives	645 428	2 700	9 609	18 393	1 126	56 262	703	194	1 103	5 917	676	1 542	1 525	1 510	4 086

Table 1. Industry Group of Employed Persons by Occupation, Age, and Sex: 1970—Continued

[Data based on 5 percent sample see text For meaning of symbols see text]

United States	Total	Agriculture, forestry, and fisheries	Mining	Construction		Manufacturing									
				Total	Special trade contractors	Total	Lumber and wood products, except furniture	Furniture and fixtures	Stone, clay, and glass products	Primary ferrous industries	Primary nonferrous industries	Fabricated metal industries (including not specified metal)	Machinery, except electrical	Electrical machinery, equipment, and supplies	Motor vehicles and motor vehicle equipment
PERSONS 16 YEARS OLD AND OVER—Continued															
Male, employed—Continued															
Laborers, except farm	**3 150 252**	**163 193**	**24 985**	**599 097**	**121 859**	**806 039**	**138 626**	**14 396**	**45 869**	**86 818**	**16 364**	**40 879**	**39 642**	**27 402**	**35 899**
Construction laborers	590 648	1 082	3 302	513 674	113 376	24 453	1 339	866	3 771	4 943	853	1 886	1 274	407	526
Freight, stock, and material handlers	1 200 094	2 120	13 657	13 857	6 286	315 248	38 248	7 386	20 180	18 869	4 438	16 340	17 107	16 167	20 682
Vehicle washers and equipment cleaners	105 663	230	631	860	280	32 587	380	209	1 287	1 763	693	1 569	3 083	1 110	2 959
Other specified laborers	705 681	151 536	1 655	69 529	1 899	155 015	78 773	697	1 204	1 412	570	1 834	1 544	1 553	1 166
Miscellaneous laborers	185 372	5 200	2 193	42	–	81 615	6 819	572	3 205	31 125	2 772	7 119	5 181	1 540	2 920
Not specified laborers	362 794	3 025	3 547	1 135	18	197 121	13 067	4 666	16 222	28 706	7 038	12 131	11 453	6 625	7 646
Farm workers	**2 155 568**	**2 155 568**	–	–	–	–	–	–	–	–	–	–	–	–	–
Service workers, including private household	**3 877 558**	**11 190**	**9 356**	**37 698**	**5 465**	**382 714**	**9 321**	**6 260**	**11 410**	**24 592**	**7 640**	**19 778**	**30 227**	**28 070**	**26 510**
Cleaning service workers	1 257 185	5 669	5 283	21 000	3 336	243 965	4 797	4 231	8 450	16 644	5 315	14 191	22 190	18 947	18 439
Food service workers	867 705	834	874	1 013	211	10 367	144	39	92	164	71	83	569	530	231
Health service workers	143 098	695	89	63	63	772	–	–	–	147	112	–	58	40	99
Personal service workers	391 644	461	184	1 794	274	7 836	45	40	211	231	154	305	389	270	414
Guards and watchmen	305 902	1 737	2 325	6 250	485	76 949	3 583	1 586	2 225	6 108	1 769	4 012	5 516	7 122	6 185
Other service workers, including private household	912 024	1 794	601	7 578	1 096	42 825	752	364	432	1 298	219	1 187	1 505	1 161	1 142
Female, employed	**29 074 510**	**329 602**	**51 367**	**269 784**	**111 970**	**5 678 651**	**53 678**	**108 136**	**110 579**	**61 700**	**49 684**	**220 035**	**327 935**	**736 368**	**130 940**
Professional, technical, and kindred workers	**4 575 990**	**7 646**	**4 258**	**11 736**	**2 483**	**220 966**	**934**	**1 209**	**4 702**	**2 877**	**2 126**	**5 601**	**15 409**	**27 950**	**4 086**
Accountants	179 845	644	1 144	3 802	955	27 514	427	311	811	535	457	1 901	3 027	3 973	974
Computer specialists	50 254	144	324	454	20	13 537	–	91	154	146	86	270	3 685	2 122	507
Engineers	20 077	32	168	1 516	105	8 448	60	23	126	178	58	229	938	2 433	193
Librarians, archivists, and curators	101 008	21	163	74	–	2 565	17	–	18	105	21	21	173	258	40
Life and physical scientists	26 886	565	583	30	–	7 563	17	16	184	149	157	223	293	253	34
Physicians, dentists, and related practitioners	44 417	909	–	–	–	508	–	–	–	–	20	21	–	45	–
Registered nurses dietitians, and therapists	899 102	355	192	273	17	13 788	27	115	401	965	365	777	1 569	1 857	1 306
Health technologists and technicians	182 173	105	–	–	–	578	–	–	–	34	–	–	21	22	–
Social scientists	20 217	66	40	–	–	1 731	33	–	–	23	–	43	127	208	67
Social and recreation workers	157 337	–	–	22	–	222	–	23	19	–	–	–	–	38	–
Teachers, except college and university	1 936 646	55	–	104	54	4 490	–	141	175	–	22	41	313	725	45
Engineering and science technicians	88 305	580	999	2 289	230	44 198	95	86	854	398	468	1 003	2 550	9 788	378
Technicians, exc health, and engineering and science	16 992	147	69	176	–	698	–	–	22	16	–	–	63	129	18
Writers, artists, and entertainers	229 309	1 995	76	1 292	707	63 698	98	161	1 448	22	164	346	1 089	2 528	161
Other professional, technical, and kindred workers	623 422	2 028	500	1 704	395	31 428	160	242	490	306	308	726	1 561	3 571	363
Managers and administrators, except farm	**1 061 076**	**2 892**	**1 509**	**12 114**	**5 203**	**68 838**	**1 212**	**1 917**	**1 596**	**799**	**722**	**3 486**	**5 841**	**5 551**	**733**
Buyers, purchasing agents, and sales managers	134 825	212	226	640	199	12 584	158	294	163	189	136	771	1 518	1 585	131
Other managers and administrators	926 251	2 680	1 283	11 474	5 004	56 254	1 054	1 623	1 433	610	586	2 715	4 323	3 966	602
Salaried	714 912	1 377	1 091	8 872	3 814	49 172	855	1 370	1 032	610	586	2 470	4 090	3 807	514
Self-employed	211 339	1 303	192	2 602	1 190	7 082	199	253	401	–	–	245	233	159	88
Sales workers	**2 142 509**	**3 616**	**242**	**3 759**	**1 693**	**57 465**	**370**	**692**	**819**	**207**	**227**	**909**	**1 425**	**2 459**	**164**
Clerical and kindred workers	**10 149 827**	**43 732**	**36 359**	**189 516**	**76 488**	**1 560 562**	**17 764**	**25 882**	**35 441**	**37 592**	**20 827**	**82 786**	**160 676**	**175 060**	**45 394**
Billing clerks	84 408	167	298	914	540	25 390	366	837	922	903	447	1 483	2 588	2 506	506
Bookkeepers	1 273 708	13 372	5 279	53 115	27 793	196 753	5 571	4 728	6 066	3 383	2 582	12 556	18 954	16 109	4 128
Cashiers	691 729	326	66	350	57	7 383	15	85	111	36	81	100	524	601	417
Counter clerks, except food	149 635	157	127	196	102	20 839	136	374	289	402	163	481	1 425	1 947	306
File clerks	297 452	497	909	2 751	942	53 310	177	639	608	987	709	2 342	6 140	7 273	1 941
Office machine operators	413 611	842	2 043	4 022	756	104 642	720	1 417	1 929	4 019	1 508	4 878	13 260	13 087	5 617
Bookkeeping and billing machine operators	57 812	75	134	701	246	7 765	98	121	224	139	125	547	867	636	120
Keypunch operators	247 862	457	1 488	2 685	442	68 360	428	875	1 232	2 888	1 097	3 197	9 266	9 047	3 751

Table 1. Industry Group of Employed Persons by Occupation, Age, and Sex: 1970 – Continued

[Data based on 5 percent sample see text For meaning of symbols, see text]

United States	Total	Agriculture, forestry, and fisheries	Mining	Construction		Manufacturing									
				Total	Special trade contractors	Total	Lumber and wood products, except furniture	Furniture and fixtures	Stone, clay, and glass products	Primary ferrous industries	Primary nonferrous industries	Fabricated metal industries (including not specified metal)	Machinery, except electrical	Electrical machinery, equipment, and supplies	Motor vehicles and motor vehicle equipment
PERSONS 16 YEARS OLD AND OVER – Continued															
Female, employed – Continued															
Clerical and kindred workers – Continued															
Payroll and timekeeping clerks	107 484	530	732	5 203	1 565	44 888	574	1 230	1 336	1 413	837	3 108	5 169	4 254	1 302
Receptionists	288 964	4 170	805	3 679	1 324	26 539	247	708	801	439	418	2 104	3 033	2 280	818
Secretaries	2 642 576	11 330	17 020	75 449	30 932	501 468	6 376	7 952	13 825	12 792	8 389	29 899	62 708	64 919	16 359
Statistical clerks	158 040	484	520	878	188	26 222	200	335	506	805	175	1 035	2 792	4 081	828
Stenographers	119 990	606	1 107	2 540	445	19 808	95	159	512	1 267	378	1 305	2 248	2 098	1 112
Telephone operators	391 641	120	530	1 509	554	24 433	158	512	631	715	535	1 356	2 769	3 020	854
Typists	922 777	3 110	2 649	13 499	3 850	170 810	876	2 413	2 709	5 215	2 265	9 505	17 841	22 420	5 122
Other clerical and kindred workers	2 607 812	8 021	4 274	25 411	7 440	338 077	2 253	4 493	5 196	5 216	2 340	12 634	21 225	30 465	6 084
Craftsmen and kindred workers	**517 648**	**1 854**	**1 768**	**30 042**	**18 375**	**261 414**	**3 588**	**11 002**	**2 914**	**4 109**	**2 625**	**8 898**	**11 939**	**29 354**	**5 035**
Foremen, n e c	126 344	220	633	1 416	405	77 838	434	1 679	974	549	546	2 206	2 433	9 045	881
Mechanics and repairmen	49 170	149	240	1 331	719	21 412	80	130	321	230	212	742	1 825	6 353	1 363
Printing craftsmen	57 860	41	-	99	41	49 725	101	121	67	33	35	536	720	1 048	114
Operatives, except transport	**4 035 745**	**9 848**	**5 489**	**5 895**	**3 615**	**3 331 847**	**23 009**	**63 620**	**59 452**	**11 740**	**21 442**	**108 316**	**124 546**	**479 615**	**69 944**
Assemblers	459 134	147	112	562	428	442 587	2 688	10 344	3 561	1 017	3 223	22 349	46 814	198 166	26 691
Bottling and canning operatives	16 082	62	-	-	-	15 364	27	-	-	-	-	233	103	260	37
Checkers, examiners, inspectors, manufacturing	332 638	-	-	-	-	332 638	1 251	3 556	18 784	1 901	3 482	13 571	18 301	77 128	8 710
Graders and sorters, manufacturing	24 113	-	-	-	-	24 113	1 025	37	827	218	149	529	131	952	157
Packers and wrappers except produce	355 696	3 887	43	121	66	236 967	1 694	3 332	11 068	772	1 441	8 874	4 793	12 450	2 305
Produce graders and packers, exc factory and farm	20 207	992	-	-	-	21	-	-	-	-	-	-	-	-	-
Mixing operatives	2 616	-	23	-	-	2 402	-	42	145	-	38	42	37	202	22
Sewers and stitchers	816 441	90	-	224	198	786 402	167	15 278	580	30	59	543	660	1 397	3 729
Other specified operatives	1 289 083	2 040	5 271	3 943	2 380	856 784	5 708	17 170	6 173	3 521	5 783	32 241	30 334	81 728	14 701
Machine operatives, miscellaneous specified	290 945	665	21	286	119	266 012	4 496	5 420	9 548	1 677	3 541	10 651	7 824	40 569	4 967
Machine operatives not specified	150 621	86	-	241	111	138 587	1 673	2 987	2 151	1 250	1 903	12 325	8 781	22 711	5 101
Miscellaneous operatives	187 870	1 716	19	316	167	152 047	3 050	3 955	4 879	628	1 230	4 074	3 967	27 334	1 805
Not specified operatives	90 299	163	-	202	146	77 923	1 230	1 499	1 736	726	593	2 884	2 801	16 718	1 719
Transport equipment operatives	**133 898**	**814**	**407**	**1 868**	**380**	**10 207**	**582**	**154**	**786**	**334**	**104**	**454**	**289**	**618**	**721**
Deliverymen and routemen	19 163	255	-	102	34	2 757	-	-	25	23	-	38	18	51	111
Laborers, except farm	**280 385**	**18 941**	**329**	**8 341**	**2 141**	**101 479**	**5 175**	**2 434**	**3 457**	**1 715**	**1 013**	**7 392**	**3 142**	**9 818**	**2 005**
Farm workers	**233 251**	**233 251**	-	-	-	-	-	-	-	-	-	-	-	-	-
Service workers, except private household[1]	**4 812 200**	**7 008**	**1 006**	**6 513**	**1 592**	**65 873**	**1 044**	**1 226**	**1 412**	**2 327**	**598**	**2 193**	**4 668**	**5 943**	**2 858**
Cleaning service workers	596 487	2 837	643	4 350	812	29 681	680	732	784	1 549	407	1 112	2 419	2 541	1 317
Cleaners and charwomen	249 295	1 686	238	2 192	440	13 393	312	304	419	587	188	448	984	1 104	461
Food service workers	1 913 363	2 235	135	324	125	14 932	168	151	147	502	58	384	1 319	1 244	940
Waiters and food counter workers	1 027 762	303	92	158	58	4 893	27	22	17	259	21	125	487	626	250
Health service workers	1 046 885	336	21	122	19	1 782	-	43	83	136	-	233	126	70	73
Personal service workers	777 896	727	76	232	48	5 329	38	66	154	21	46	106	164	551	149
Protective service workers	59 350	81	13	275	40	1 954	33	38	56	-	87	53	53	290	145
Private household workers	**1 131 981**	-	-	-	-	-	-	-	-	-	-	-	-	-	-

[1] Includes allocated cases not shown separately

Table 1. Industry Group of Employed Persons by Occupation, Age, and Sex: 1970—Continued

[Data based on 5 percent sample see text For meaning of symbols see text]

United States	Manufacturing—Con												Transportation, communications, and other public utilities			
	Aircraft and parts	Other transportation equipment	Ordnance	Other durable goods	Food and kindred products	Textile mill products	Apparel and other fabricated textile products	Paper and allied products	Printing, publishing and allied industries	Chemicals and allied products	Rubber and miscellaneous plastic products	Other nondurable goods	Total[1]	Railroads and railway express service	Trucking service and warehousing	Other transportation
PERSONS 16 YEARS OLD AND OVER—Continued																
Male, employed	**607 470**	**377 125**	**205 624**	**979 328**	**1 026 525**	**520 967**	**270 129**	**508 505**	**787 529**	**762 804**	**363 672**	**677 155**	**4 085 682**	**595 859**	**979 460**	**872 879**
Professional, technical, and kindred workers	**181 208**	**34 421**	**69 643**	**124 068**	**50 591**	**24 348**	**13 240**	**39 880**	**97 661**	**158 971**	**34 434**	**71 341**	**350 618**	**17 475**	**10 129**	**85 713**
Accountants	7 968	2 413	2 827	7 052	9 676	2 991	1 611	5 043	5 936	11 039	3 623	7 633	31 013	4 330	3 505	6 761
Architects	21	762	82	89	103	37	–	35	59	94	19	41	684	37	–	363
Computer specialists	7 367	703	3 639	3 075	2 270	1 434	996	1 491	2 489	4 388	1 272	2 818	11 303	1 165	546	2 230
Engineers	103 115	13 769	39 246	33 270	11 280	6 244	2 534	10 398	2 575	42 931	12 241	16 907	105 697	4 750	1 216	14 360
Aeronautical and astronautical	51 866	83	4 142	383	–	–	–	37	16	–	–	19	1 106	–	–	1 083
Chemical	726	107	701	1 076	851	254	68	1 254	21	23 565	1 761	5 969	861	–	17	16
Civil	2 506	437	895	512	452	46	40	485	40	1 546	219	902	13 360	2 436	117	1 542
Electrical and electronic	14 933	2 673	9 009	5 425	741	248	20	781	247	2 100	692	1 062	60 540	838	141	1 124
Industrial	13 433	2 494	5 952	8 408	4 945	3 796	1 873	3 136	1 261	6 135	3 568	2 221	5 525	531	480	1 255
Mechanical	12 239	5 569	8 837	5 218	1 968	901	235	1 746	439	4 724	1 818	2 391	13 941	423	236	8 404
Other engineers	7 412	2 406	9 710	12 248	2 323	999	298	2 959	551	4 861	4 183	4 343	10 364	522	225	936
Lawyers and judges	439	80	121	546	431	189	43	209	321	1 485	129	916	3 480	554	357	658
Librarians, archivists, and curators	71	19	19	21	21	–	–	20	257	132	–	60	754	–	–	38
Mathematical specialists	895	19	528	213	194	56	20	99	166	731	86	235	1 392	355	66	125
Life and physical scientists	2 410	514	1 473	3 026	5 263	1 592	81	2 134	326	32 162	2 591	5 148	3 912	111	25	427
Chemists	1 388	325	564	2 056	4 475	1 547	60	1 924	171	28 988	2 554	4 167	2 144	92	25	171
Operations and systems researchers and analysts	7 769	1 479	2 481	2 111	1 057	706	294	1 408	1 045	2 377	1 064	1 094	3 230	410	132	1 021
Personnel and labor relations workers	4 042	1 079	1 931	3 068	3 834	2 910	924	2 669	1 913	5 517	2 063	2 816	15 965	1 524	2 083	3 274
Physicians, dentists, and related practitioners	44	80	19	64	232	–	20	54	21	1 155	–	18	334	31	20	78
Dentists	–	19	–	22	–	–	–	19	–	–	–	–	–	–	–	–
Pharmacists	–	–	–	–	22	–	20	–	–	559	–	–	56	–	20	–
Physicians, medical and osteopathic	44	61	19	20	65	–	–	35	–	460	–	18	204	31	–	19
Other related practitioners	–	–	–	22	145	–	–	–	21	136	–	–	74	–	–	59
Registered nurses, dietitians, and therapists	66	23	19	62	217	–	–	–	19	61	–	19	96	21	–	27
Health technologists and technicians	105	259	59	1 564	36	–	–	33	65	732	17	161	598	28	–	103
Religious workers	–	18	15	–	–	–	–	–	65	–	–	–	16	–	16	–
Social scientists	1 768	187	648	1 345	1 587	187	138	578	916	3 037	639	1 573	3 194	232	45	667
Social and recreation workers	43	–	21	27	16	132	–	–	59	–	77	–	155	–	19	–
Teachers, college and university	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Teachers, except college and university	978	321	333	488	92	461	68	189	160	296	172	60	3 372	129	105	2 295
Engineering and science technicians	30 537	8 890	10 895	19 052	9 147	4 919	1 185	10 018	2 347	42 126	7 882	12 508	47 336	2 546	499	3 864
Draftsmen	9 898	4 709	2 766	6 707	1 068	514	817	1 282	1 252	3 980	1 794	2 699	12 490	1 174	79	715
Electrical and electronic engineering technicians	8 236	1 698	3 850	3 653	136	72	–	244	358	864	142	513	21 985	579	80	1 384
Industrial and mechanical engineering technicians	5 079	432	907	1 151	674	578	61	375	138	1 504	584	239	473	37	58	169
Other engineering and science technicians	7 324	2 051	3 372	7 541	7 269	3 755	307	8 117	599	35 778	5 362	9 057	12 388	756	282	1 596
Technicians, exc. health, and eng. and science	3 627	294	586	451	323	257	68	365	147	704	418	391	55 272	147	591	45 581
Airplane pilots	1 113	98	84	68	263	128	68	121	18	207	58	170	39 888	–	173	39 332
Embalmers	–	–	–	–	–	–	–	22	–	–	–	–	20	–	20	–
Radio operators and air traffic controllers	110	49	95	–	60	–	–	21	25	36	–	47	7 205	89	315	1 423
Other technicians, exc health, and eng. and science	2 404	147	407	383	–	129	–	201	104	461	360	174	8 159	58	83	4 826
Writers, artists, and entertainers	7 758	2 889	3 267	8 039	2 510	1 742	5 205	2 843	77 220	3 505	1 590	2 278	45 940	515	671	2 906
Other professional, technical, and kindred workers	2 185	623	1 434	40 505	2 302	491	53	2 294	1 555	6 499	551	16 665	16 875	590	233	935
Managers and administrators, except farm	**32 116**	**16 728**	**13 056**	**73 351**	**90 923**	**25 593**	**33 735**	**31 226**	**81 291**	**70 651**	**26 591**	**43 541**	**341 537**	**75 117**	**69 370**	**70 566**
Buyers, purchasing agents, and sales managers	7 085	3 740	2 280	10 252	22 123	3 613	4 533	7 441	20 052	16 218	5 263	6 543	21 858	2 245	3 130	4 879
Other managers and administrators	25 031	12 988	10 776	63 099	68 800	21 980	29 202	23 785	61 239	54 433	21 328	36 998	319 679	72 872	66 240	65 687
Salaried	24 656	11 721	10 652	55 389	62 952	20 865	25 531	23 104	51 873	52 982	20 471	33 971	295 635	72 872	52 342	59 801
Self-employed	375	1 267	124	7 710	5 848	1 115	3 671	681	9 366	1 451	857	3 027	24 044	–	13 898	5 886
Sales workers	**2 985**	**3 674**	**881**	**33 415**	**51 661**	**9 996**	**20 104**	**16 476**	**102 052**	**47 871**	**10 419**	**37 197**	**53 396**	**3 052**	**12 297**	**7 794**
Newsboys	–	–	–	–	–	–	–	–	48 812	–	–	–	–	–	–	–
Other specified sales workers	555	331	213	6 467	1 013	42	40	353	14 631	728	295	20 723	12 538	631	79	398
Salesmen and sales clerks, n.e.c	2 430	3 343	668	26 948	50 648	9 954	20 064	16 123	38 609	47 143	10 124	16 474	40 858	2 421	12 218	7 396

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[1] Includes allocated cases not shown separately

Table 1. Industry Group of Employed Persons by Occupation, Age, and Sex: 1970—Continued

[Data based on 5 percent sample see text For meaning of symbols, see text]

United States	Manufacturing—Con												Transportation, communications, and other public utilities			
	Aircraft and parts	Other transportation equipment	Ordnance	Other durable goods	Food and kindred products	Textile mill products	Apparel and other fabricated textile products	Paper and allied products	Printing, publishing and allied industries	Chemicals and allied products	Rubber and miscellaneous plastic products	Other nondurable goods	Total¹	Railroads and railway express service	Trucking service and warehousing	Other transportation
PERSONS 16 YEARS OLD AND OVER—Continued																
Male, employed—Continued																
Clerical and kindred workers	**48 536**	**20 663**	**15 099**	**63 603**	**52 969**	**30 410**	**27 213**	**30 902**	**69 649**	**50 583**	**23 721**	**46 094**	**435 756**	**90 283**	**75 589**	**113 578**
Bookkeepers	2 191	1 256	982	2 636	7 350	1 615	1 542	1 942	3 805	4 654	1 377	3 529	26 050	5 478	5 732	4 167
Cashiers	102	22	–	111	515	70	41	58	187	72	38	86	11 241	1 025	820	8 433
Estimators and investigators, n e c	2 302	2 084	557	1 290	708	394	271	1 036	3 316	1 573	603	859	18 396	3 511	2 745	1 787
Office machine operators	3 213	509	1 450	2 293	2 133	1 387	923	1 545	4 832	3 516	1 127	2 236	12 467	4 603	1 301	1 871
Secretaries, stenographers, and typists	742	406	228	1 432	1 187	608	784	774	4 169	1 135	636	953	15 199	5 405	2 744	2 779
Shipping and receiving clerks	3 073	2 088	1 081	10 635	16 248	12 181	14 710	8 835	8 521	12 979	8 224	6 932	34 187	4 449	19 239	8 782
Stock clerks and storekeepers	9 733	4 271	3 134	6 912	6 077	4 527	3 036	4 447	2 806	6 092	3 762	4 140	27 858	7 197	3 946	6 695
Other clerical and kindred workers	27 180	10 027	7 667	38 294	18 751	9 628	5 906	12 265	42 013	20 562	7 954	27 359	290 358	58 615	39 062	79 064
Craftsmen and kindred workers	**166 798**	**166 196**	**43 557**	**234 157**	**183 774**	**126 868**	**58 757**	**112 859**	**321 265**	**152 248**	**73 664**	**139 386**	**1 130 424**	**207 990**	**88 848**	**146 103**
Construction craftsmen	17 186	69 974	5 366	10 759	13 768	8 344	1 394	14 903	3 520	27 776	7 479	12 343	105 403	24 809	3 211	13 185
Brickmasons and stonemasons	83	120	–	96	166	43	47	146	88	437	57	154	733	130	48	130
Carpenters	1 631	28 531	1 396	2 311	2 353	1 815	438	1 548	516	3 727	698	2 185	12 433	5 569	687	2 867
Electricians	10 326	14 479	1 584	4 286	6 038	4 680	704	7 029	1 647	9 367	3 280	2 973	46 150	10 841	379	5 622
Excavating, grading and road machine operators	229	410	208	153	1 564	107	–	1 197	64	1 793	371	708	14 384	1 804	1 255	833
Painters (const & maint), plasterers, & paperhangers	2 534	8 886	730	1 837	1 268	340	102	661	728	1 891	558	584	7 444	2 474	407	2 666
Plumbers and pipefitters	1 974	14 442	1 309	1 724	2 238	1 210	28	4 151	304	9 972	2 297	5 398	22 182	3 702	124	724
Other construction craftsmen	409	3 106	139	352	141	149	75	171	173	589	218	341	2 077	289	311	343
Foremen, n e c	33 306	21 000	12 237	36 361	60 460	45 862	17 849	33 865	30 952	55 972	30 513	31 209	148 123	25 424	27 272	15 875
Mechanics and repairmen	50 344	14 113	11 174	22 153	47 880	58 511	10 972	24 292	10 958	36 217	17 626	16 752	286 380	51 531	48 643	100 306
Automobile including body	807	752	564	571	8 088	498	152	737	460	1 162	626	901	77 868	636	43 525	23 299
Metal craftsmen except mechanics	59 474	40 860	11 292	33 400	10 908	7 443	1 846	15 898	4 322	16 619	13 767	11 235	28 992	14 996	995	4 862
Machinists, job setters and toolmakers	39 759	17 982	8 823	22 787	7 696	6 456	1 525	8 324	3 010	9 587	12 000	8 100	17 440	10 338	421	2 432
Blacksmiths forgemen, hammermen, boilermakers	849	2 935	87	445	400	107	20	557	570	1 192	101	1 103	5 416	2 351	61	127
Other metal craftsmen	18 866	19 943	2 382	10 168	2 812	880	301	7 017	742	5 840	1 666	2 032	6 136	2 307	513	2 303
Printing craftsmen	829	339	352	1 785	930	2 470	671	14 055	267 927	1 671	1 282	1 456	2 274	216	266	413
Stationary engineers and power station operators	1 466	840	933	1 628	7 115	1 149	264	4 159	866	6 980	940	5 869	63 966	1 433	1 025	3 370
Other craftsmen and kindred workers	4 193	19 070	2 203	128 071	42 713	3 089	25 761	5 687	2 720	7 013	2 057	60 522	495 286	89 581	7 436	8 092
Operatives, except transport	**152 727**	**101 196**	**46 194**	**333 802**	**291 504**	**242 929**	**93 918**	**203 232**	**67 194**	**198 623**	**155 638**	**243 978**	**157 258**	**27 297**	**17 921**	**48 600**
Assemblers	34 668	11 073	7 625	20 438	4 322	798	794	2 545	1 237	2 943	4 284	4 970	1 671	237	367	268
Checkers, examiners, and inspectors, manufacturing	27 648	5 891	10 208	12 796	10 873	11 241	3 344	5 999	1 816	7 815	12 683	24 156	–	–	–	-
Filers polishers, sanders, and buffers	3 599	910	664	9 601	252	277	143	316	102	764	954	1 055	325	81	41	119
Painters, manufactured articles	3 191	4 676	886	4 165	974	494	271	1 152	302	1 902	1 402	1 509	330	–	39	84
Precision machine operatives	25 271	5 305	3 746	10 148	1 284	1 602	228	1 211	426	1 538	3 317	2 506	1 934	848	127	216
Drill press operatives	3 111	1 174	799	2 244	53	209	47	304	61	109	555	710	184	83	–	17
Grinding machine operatives	7 754	1 423	884	1 706	583	86	23	305	27	332	515	344	390	260	–	44
Lathe and milling machine operatives	11 710	2 142	1 448	4 225	454	624	81	406	317	941	1 927	1 229	795	245	56	134
Precision machine operatives, n e c	2 696	566	615	1 973	194	683	77	196	21	156	320	223	565	260	71	21
Punch and stamping press operatives	2 625	1 458	430	2 773	141	91	175	653	551	341	955	869	471	168	75	28
Solderers	181	109	76	877	41	–	–	–	–	37	–	145	60	–	23	-
Stationary firemen	1 332	502	676	992	3 618	2 117	368	4 399	164	5 459	1 145	3 185	11 511	636	200	1 364
Welders and flame-cutters	8 678	38 412	2 962	7 705	3 512	1 149	181	3 160	289	6 828	1 689	5 793	23 131	9 322	1 614	2 408
Other specified operatives	11 109	10 169	3 884	195 968	130 909	225 160	66 102	48 260	19 340	47 965	21 972	129 738	54 857	2 960	10 025	25 657
Machine operatives, miscellaneous specified	9 685	5 866	5 410	26 816	70 207	–	8 278	82 526	19 077	52 687	69 623	35 236	8 184	765	1 609	659
Machine operatives not specified	11 814	2 811	5 384	14 735	20 532	–	1 620	28 792	7 055	41 727	16 884	11 413	9 018	3 114	752	640
Miscellaneous operatives	6 432	8 832	2 432	16 620	30 852	–	9 333	16 670	15 107	15 750	13 115	14 133	39 011	5 790	2 612	16 695
Not specified operatives	6 494	5 182	1 791	10 168	13 987	–	3 081	7 549	1 728	12 867	7 615	9 270	6 755	3 376	437	462
Transport equipment operatives	**4 850**	**8 709**	**4 523**	**32 132**	**163 488**	**12 515**	**4 811**	**28 397**	**20 018**	**25 535**	**10 442**	**27 118**	**1 095 339**	**98 494**	**583 663**	**288 689**
Deliverymen and routemen	571	1 106	246	2 783	94 331	829	1 246	1 991	9 914	3 410	694	2 381	47 375	1 035	39 706	2 913
Fork lift and tow motor operatives	1 674	1 870	1 827	3 758	18 944	4 822	469	13 518	2 089	7 449	4 872	3 179	15 141	1 400	9 243	3 580
Truck drivers	2 077	5 029	1 908	7 421	47 990	6 389	2 940	11 788	7 080	13 455	4 320	9 162	595 718	7 450	532 055	8 218
Other transport equipment operatives	528	704	542	18 170	2 223	475	156	1 100	935	1 221	556	12 396	437 105	88 609	2 659	273 978

[1] Includes allocated cases not shown separately

The National Industry-Occupation Employment Matrix, 1970, 1978, and Projected 1990

Volume I

U.S. Department of Labor
Bureau of Labor Statistics
April 1981

Bulletin 2086

Table 1. Percent distribution of industry employment by occupation, 1970, 1978 and projected 1990

	Total all industries			Agricultre, forestry, fisheries			Agriculture		
	1970	1978	1990	1970	1978	1990	1970	1978	1990
Total all occupations	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Professional and technical	13.88	15.09	14.78	2.13	3.24	4.20	1.38	1.99	2.75
Engineers,technical	1.40	1.23	1.24	.06	.09	.12	.02	.02	.04
Aeronautical	.08	.06	.06	.00	.00	.00	.00	.00	.00
Chemical	.06	.06	.06	.00	.00	.00	.00	.00	.00
Civil	.21	.16	.17	.04	.06	.07	.01	.01	.02
Electrical	.36	.32	.32	.00	.00	.00	.00	.00	.00
Industrial	.20	.20	.20	.00	.00	.00	.00	.00	.00
Mechanical	.24	.21	.20	.01	.01	.02	.00	.00	.00
Metallurgical	.02	.02	.02	.00	.00	.00	.00	.00	.00
Petroleum	.02	.02	.02	.00	.00	.00	.00	.00	.00
Sales	.05	.04	.03	.00	.00	.00	.00	.00	.00
Other engineers	.17	.15	.16	.01	.02	.02	.01	.01	.02
Life and physical scientists	.26	.30	.31	.12	.21	.35	.09	.15	.28
Agricultural	.02	.02	.02	.09	.15	.25	.08	.13	.22
Atmospheric and space	.01	.01	.01	.00	.01	.00	.00	.00	.00
Biological	.04	.07	.07	.02	.05	.08	.01	.02	.05
Chemists	.14	.13	.13	.01	.01	.02	.00	.01	.02
Geologists	.03	.03	.04	.00	.00	.00	.00	.00	.00
Physicists and astronomers	.03	.03	.02	.00	.00	.00	.00	.00	.00
Mathematical specialists	.04	.05	.05	.00	.00	.00	.00	.00	.00
Actuaries	.01	.01	.01	.00	.00	.00	.00	.00	.00
Mathematicians	.01	.01	.01	.00	.00	.00	.00	.00	.00
Statisticians	.03	.02	.03	.00	.00	.00	.00	.00	.00
Engineering,science technicians	1.04	1.03	1.09	.16	.28	.41	.12	.21	.34
Agricultural,biolgcl,exc health	.05	.05	.05	.09	.16	.28	.09	.17	.28
Chemical technicians	.10	.09	.10	.00	.00	.00	.00	.00	.00
Drafters	.34	.31	.35	.02	.03	.04	.01	.02	.02
Electrical and electronic	.20	.21	.22	.00	.01	.00	.00	.00	.00
Industrial engineering	.03	.03	.03	.00	.00	.00	.00	.00	.00
Mechanical engineering	.02	.02	.02	.00	.00	.00	.00	.00	.00
Surveyors	.08	.08	.08	.02	.03	.03	.01	.01	.01
Other engineering,science tech	.24	.24	.25	.02	.04	.05	.01	.02	.03
Medical workers,exc technicians	1.77	2.03	2.36	.55	.71	.89	.57	.74	.93
Chiropractors	.02	.02	.02	.00	.00	.00	.00	.00	.00
Dentists	.12	.13	.14	.00	.00	.00	.00	.00	.00
Dietitians	.04	.04	.04	.00	.00	.00	.00	.00	.00
Optometrists	.02	.02	.02	.00	.00	.00	.00	.00	.00
Pharmacists	.15	.14	.16	.00	.00	.00	.00	.00	.00
Physicians and osteopaths	.37	.40	.44	.00	.00	.00	.00	.00	.00
Podiatrists	.01	.01	.01	.00	.00	.00	.00	.00	.00
Registered nurses	.91	1.06	1.28	.01	.00	.00	.01	.00	.00
Therapists	.10	.17	.20	.00	.00	.00	.00	.00	.00
Veterinarians	.03	.03	.04	.54	.70	.89	.56	.73	.93
Health technologists,technicians	.35	.54	.59	.01	.01	.02	.01	.01	.02
Clinical lab technologists,tech	.17	.23	.23	.00	.00	.00	.00	.00	.00
Dental hygienists	.02	.04	.06	.00	.00	.00	.00	.00	.00
Health record technologist,tech	.02	.02	.02	.00	.00	.00	.00	.00	.00
Radiologic technologists,tech	.07	.11	.12	.00	.00	.00	.00	.00	.00
Other health technicians	.08	.14	.15	.01	.01	.01	.01	.01	.01
Technicians,except health	.20	.23	.25	.09	.13	.19	.07	.10	.16
Airplane pilots	.06	.08	.09	.07	.10	.16	.07	.10	.16
Air traffic controllers	.03	.03	.03	.00	.00	.00	.00	.00	.00
Flight engineers	.01	.01	.01	.00	.00	.00	.00	.00	.00
Radio operators	.04	.05	.05	.01	.01	.01	.00	.00	.00
Other technicians except health	.05	.06	.07	.01	.02	.02	.00	.00	.00
Computer specialists	.36	.46	.50	.01	.01	.01	.00	.00	.00
Computer programers	.22	.26	.28	.00	.01	.01	.00	.00	.00
Computer systems analysts	.11	.17	.19	.00	.00	.00	.00	.00	.00
Other computer specialists	.02	.03	.03	.00	.00	.00	.00	.00	.00
Social scientists	.15	.28	.32	.00	.01	.01	.00	.00	.00
Economists	.08	.13	.15	.00	.01	.01	.00	.00	.00
Psychologists	.04	.12	.13	.00	.00	.00	.00	.00	.00
Urban and regional planners	.01	.02	.02	.00	.00	.00	.00	.00	.00

Table 1. Percent distribution of industry employment by occupation, 1970, 1978 and projected 1990

	Metal mining			Coal mining			Crude petroleum, natural gas		
	1970	1978	1990	1970	1978	1990	1970	1978	1990
Other crafts, kindred workers	2.83	2.47	2.32	2.47	2.47	2.31	6.46	5.13	2.85
Crane,derrick,hoist operator	1.79	1.53	1.79	.48	.41	.46	.50	.48	.75
Inspectors, other	.36	.37	.20	.80	.98	1.02	.48	.58	.60
Stationary engineers	.57	.46	.24	1.17	1.06	.84	5.41	4.00	1.43
Other crafts workers	.11	.11	.09	.02	.01	.01	.06	.07	.08
Operatives	43.94	39.64	35.68	52.51	49.53	50.37	36.51	34.39	36.98
Operatives,except transport	37.17	32.24	25.06	44.03	40.91	41.03	32.95	30.65	32.07
Semiskilled metalworking	3.35	3.81	4.74	1.79	1.87	1.57	1.43	1.54	1.82
Furnace tendr,smeltrs,pourers	.23	.24	.20	.00	.00	.00	.00	.00	.00
Grinding machine operatives	.13	.11	.09	.04	.02	.02	.21	.17	.11
Heaters, metal	.01	.01	.02	.00	.00	.00	.00	.00	.00
Lathe,milling mach operatives	.00	.00	.00	.00	.00	.00	.06	.04	.02
Other precision mach operators	.00	.00	.00	.00	.00	.00	.01	.01	.00
Welders and flamecutters	2.97	3.45	4.42	1.75	1.84	1.55	1.15	1.32	1.68
Other operatives, exc transport	33.82	28.43	20.32	42.24	39.05	39.46	31.52	29.11	30.25
Assemblers	.00	.00	.00	.03	.03	.02	.11	.15	.26
Blasters	.71	.73	.82	1.24	1.27	1.06	.25	.23	.19
Surveyors' helpers	.10	.11	.16	.13	.16	.23	.06	.06	.06
Cutting operatives, other	.05	.06	.09	2.66	2.85	2.71	.07	.08	.08
Drillers, earth	4.08	3.92	2.84	2.46	2.21	1.33	5.73	5.96	6.74
Garage wrkr,gas station atten	.14	.10	.07	.00	.00	.00	.05	.03	.02
Meat cutters,butchers,exc mfg	.00	.00	.00	.02	.01	.01	.00	.00	.00
Mine operatives,other	27.17	21.94	14.69	34.16	30.97	32.69	24.57	21.88	22.03
Mixing operatives	.02	.02	.03	.04	.05	.07	.04	.04	.04
Oilers,greasers,exc automobiles	1.13	1.17	1.11	1.35	1.39	1.25	.35	.40	.52
Photographic process workers	.00	.00	.00	.00	.00	.00	.03	.03	.01
Sailors and deckhands	.00	.00	.00	.00	.00	.00	.11	.11	.18
Sawyers	.06	.06	.04	.07	.07	.06	.02	.02	.05
Furnace tendr,stokr,exc metal	.13	.28	.44	.07	.04	.01	.08	.06	.08
Winding operatives, other	.00	.00	.00	.00	.00	.00	.02	.01	.00
Miscellaneous machine operatves	.00	.00	.00	.01	.01	.01	.01	.01	.00
Other operatives,exc transport	.03	.03	.03	.01	.01	.01	.01	.01	.00
Transport equipment operatives	6.78	7.40	10.63	8.48	8.62	9.34	3.56	3.75	4.92
Boat operators	.00	.00	.00	.00	.00	.00	.10	.09	.07
Delivery and route workers	.04	.04	.05	.13	.12	.11	.18	.17	.17
Fork lift,tow motor operatives	.30	.38	.44	.37	.48	.57	.07	.09	.10
Rail vehicle operators, other	1.08	1.00	.70	3.45	3.24	2.25	.29	.23	.08
Railroad brake operators	.06	.08	.15	.00	.00	.00	.00	.00	.00
Railroad switch operators	.01	.01	.01	.00	.00	.00	.01	.01	.01
Taxicab drivers, chauffeurs	.04	.04	.03	.00	.00	.00	.04	.04	.04
Truck drivers	5.24	5.83	9.25	4.53	4.77	6.42	2.87	3.11	4.45
Service workers	2.36	2.22	1.64	.99	.94	.70	1.24	1.17	.95
Cleaning service workers	1.54	1.48	1.13	.60	.56	.36	.82	.77	.51
Bldg interior cleaners, other	.14	.14	.09	.08	.08	.04	.12	.11	.05
Janitors and sextons	1.40	1.34	1.05	.52	.48	.31	.71	.66	.46
Food service workers	.05	.05	.04	.01	.01	.00	.28	.25	.29
Bartenders	.01	.01	.01	.00	.00	.00	.00	.00	.00
Cooks,exc private households	.04	.03	.02	.00	.00	.00	.20	.16	.13
Dishwashers	.00	.00	.00	.00	.00	.00	.01	.01	.01
Food counter,fountain workers	.00	.00	.00	.00	.00	.00	.03	.04	.08
Waiters	.00	.00	.00	.00	.00	.00	.02	.01	.02
Other food serv wkrs,exc privt	.01	.01	.01	.00	.00	.00	.03	.03	.04
Health service workers	.05	.04	.08	.00	.00	.00	.00	.00	.00
Health aides, except nursing	.01	.01	.01	.00	.00	.00	.00	.00	.00
Nursing aides and orderlies	.03	.02	.05	.00	.00	.00	.00	.00	.00
Practical nurses	.02	.01	.01	.00	.00	.00	.00	.00	.00

Table 1. Percent distribution of industry employment by occupation, 1970, 1978 and projected 1990

	Nonmetallic mining and quarrying			Constructn			General building contractors		
	1970	1978	1990	1970	1978	1990	1970	1978	1990
Other managers,officials,proprts	7.05	8.77	8.51	9.49	12.06	9.12	15.88	21.85	12.93
Mgrs, superintendents, building	.00	.00	.00	.02	.03	.04	.06	.09	.13
Office managers, other	.49	.54	.57	.29	.31	.41	.23	.24	.31
Officers,pilots,pursers,ship	.13	.12	.13	.03	.03	.05	.00	.00	.00
Restaurant,cafe,bar,managers	.01	.01	.01	.00	.00	.00	.01	.01	.01
Other managers, administrators	6.42	8.09	7.80	9.15	11.68	8.62	15.57	21.52	12.48
Sales workers	.67	.73	.65	.39	.44	.66	.60	.58	.56
Advertising agents,sales worker	.01	.01	.01	.00	.00	.00	.00	.00	.00
Other sales workers	.66	.72	.64	.39	.44	.66	.59	.58	.56
Clerical workers	7.67	7.81	7.19	5.79	5.88	6.15	4.88	4.77	4.83
Stenographrs,typists,secretaries	2.05	1.99	1.79	1.93	1.84	1.99	1.75	1.58	1.60
Legal secretaries	.01	.01	.01	.01	.01	.01	.01	.01	.01
Other secretaries	1.78	1.77	1.62	1.55	1.56	1.70	1.58	1.45	1.47
Stenographers	.04	.02	.01	.07	.03	.01	.02	.01	.00
Typists	.23	.20	.15	.30	.25	.28	.14	.12	.13
Office machine operators	.27	.36	.24	.13	.13	.12	.07	.07	.06
Bookkeeping and billing	.03	.02	.01	.02	.01	.01	.02	.01	.02
Computer and peripheral equip	.11	.24	.17	.03	.06	.06	.01	.03	.02
Keypunch	.12	.10	.06	.06	.04	.04	.04	.03	.02
Other clerical workers	5.35	5.46	5.15	3.74	3.91	4.03	3.06	3.12	3.17
Billing clerks	.12	.13	.15	.03	.04	.06	.02	.02	.04
Bookkeepers	1.84	1.83	1.64	1.35	1.32	1.08	1.15	1.05	.91
Cashiers	.04	.06	.11	.16	.14	.25	.01	.01	.02
Clerical supervisors, other	.04	.05	.08	.05	.05	.06	.03	.04	.05
Collectors, bill and account	.02	.01	.01	.01	.01	.01	.01	.00	.00
Counter clerks,exc food	.06	.06	.07	.02	.02	.03	.01	.01	.02
Dispatchers,starters,vehicle	.42	.44	.45	.03	.04	.06	.01	.01	.01
Estimators,investigators,other	.13	.15	.11	.86	1.06	.95	.88	1.06	.99
Expediters,production controlrs	.16	.17	.15	.09	.10	.16	.09	.10	.15
File clerks	.07	.06	.06	.06	.05	.06	.04	.03	.04
Mail handlers,exc post office	.05	.06	.06	.03	.03	.03	.02	.02	.03
Messengers and office helpers	.01	.01	.01	.02	.02	.02	.02	.02	.03
Payroll,timekeeping clerks	.27	.30	.24	.24	.26	.27	.21	.22	.23
Real estate appraisers	.00	.00	.00	.04	.04	.06	.00	.00	.00
Receptionists	.07	.07	.06	.12	.11	.11	.14	.13	.13
Shipping and receiving clerks	.20	.18	.14	.04	.04	.05	.03	.03	.04
Statistical clerks	.12	.15	.16	.08	.08	.10	.03	.03	.04
Stock clerks and store keepers	.38	.34	.27	.14	.13	.19	.06	.05	.08
Telephone operators	.11	.09	.10	.03	.02	.02	.03	.02	.01
Weighers	.96	.99	.93	.03	.03	.05	.01	.01	.01
Misc clerical workers	.30	.33	.37	.32	.33	.42	.28	.28	.34
Crafts and kindred workers	27.31	28.36	31.09	53.46	53.82	55.80	52.28	50.41	55.34
Construction crafts workers	11.09	10.67	11.94	44.08	44.03	45.11	47.90	46.05	50.12
Carpenters and apprentices	.71	.76	.70	15.32	15.67	15.18	36.20	35.44	35.94
Brick,stonemasons, apprentices	.11	.09	.05	3.23	3.05	2.91	3.82	3.37	3.78
Bulldozer operators	2.05	2.02	2.69	1.08	1.11	1.52	.37	.39	.62
Cement and concrete finishers	.00	.00	.01	1.29	1.29	1.47	1.32	1.20	1.47
Electricians and apprentices	.96	.99	.90	4.24	4.75	5.24	.62	.64	.91
Excavating,grading mach operatr	6.33	6.51	7.38	4.82	4.13	4.83	1.16	1.05	1.72
Floor layers, exc tile setters	.00	.00	.00	.31	.23	.20	.10	.08	.08
Painters and apprentices	.21	.19	.13	5.51	5.30	5.10	1.42	1.31	2.13
Paperhangers	.00	.00	.00	.19	.31	.30	.02	.04	.03
Plasterers and apprentices	.00	.00	.00	.55	.43	.38	.32	.26	.42
Plumbers,pipefitters,aprentices	.13	.11	.06	4.62	4.50	4.34	1.01	.90	1.35
Roofers and slaters	.00	.00	.00	1.31	1.89	1.99	.32	.45	.57
Structural metal craft workers	.00	.00	.00	1.09	.92	1.11	1.12	.81	.91
Tile setters	.00	.00	.01	.51	.45	.55	.12	.12	.19
Blue collar worker supervisors	5.38	6.05	6.04	2.72	2.78	2.60	2.31	2.38	2.51

The National Industry-Occupation Employment Matrix, 1970, 1978, and Projected 1990

Volume II

U.S. Department of Labor
Bureau of Labor Statistics
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Table 2. Percent distribution of occupational employment by industry, 1970, 1978 and projected 1990

	Total all occupations			Professnal and technical			Engineers, technical		
	1970	1978	1990	1970	1978	1990	1970	1978	1990
Total all industries	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Agriculture,forestry,fisheries	4.52	3.69	2.69	.69	.79	.76	.18	.27	.26
Agriculture	4.40	3.53	2.57	.43	.46	.47	.04	.06	.08
Agricultral production	3.98	3.01	2.09	.06	.10	.15	.03	.05	.07
Services,except horticulture	.21	.25	.26	.33	.31	.29	.00	.00	.00
Horticultural services	.20	.26	.21	.04	.04	.03	.00	.00	.00
Forestry	.06	.08	.06	.24	.30	.25	.12	.17	.14
Fisheries	.05	.07	.05	.01	.01	.03	.0[illegible]	.02	.04
Mining	.80	.93	.92	.61	.75	.76	1.73	2.40	2.65
Metal	.11	.10	.09	.07	.06	.06	.21	.21	.25
Coal	.18	.22	.29	.02	.03	.05	.11	.16	.28
Crude petroleum and natural gas	.35	.48	.43	.47	.61	.61	1.28	1.90	2.01
Nonmetallic mining and quarrying	.14	.13	.10	.04	.03	.03	.12	.12	.10
Construction	5.94	6.26	6.05	1.76	1.40	1.52	8.29	7.08	7.32
General building contractors	1.44	1.55	1.50	.21	.18	.20	.96	.86	.87
General contractors,exc building	1.78	1.64	1.68	1.30	.96	1.03	6.24	4.99	5.12
Special trade contractors	2.71	3.06	2.85	.24	.25	.28	1.08	1.22	1.32
Manufacturing	24.97	21.84	20.71	16.98	14.35	13.53	54.26	50.08	45.78
Durable goods	14.51	13.08	12.76	11.53	9.61	9.06	45.82	42.16	38.37
Ordnance	.37	.18	.15	.70	.32	.25	3.48	1.78	1.34
Lumber and wood products	.78	.72	.64	.11	.11	.11	.19	.19	.21
Logging	.14	.13	.09	.01	.01	.01	.01	.02	.01
Sawmill,planing and mill work	.49	.44	.40	.07	.07	.07	.11	.12	.13
Miscellaneous wood products	.15	.13	.14	.02	.02	.03	.05	.05	.06
Furniture and fixtures	.59	.55	.59	.10	.10	.11	.19	.20	.19
Stone,clay,and glass products	.81	.73	.62	.36	.31	.23	.90	.85	.65
Glass and glass products	.23	.21	.19	.10	.09	.07	.26	.25	.20
Cement,concrete,plaster	.28	.26	.22	.11	.10	.07	.27	.24	.18
Structural clay products	.07	.05	.02	.02	.01	.00	.04	.02	.01
Pottery and related products	.05	.05	.03	.02	.02	.01	.05	.05	.03
Miscellaneous nonmetalic,stone	.17	.16	.13	.09	.08	.06	.27	.27	.20
Primary metal industries	1.65	1.33	1.18	.74	.59	.52	2.20	2.01	1.75
Blast furnaces,steel works	.70	.50	.42	.31	.22	.18	.87	.69	.54
Other primary steel	.46	.38	.37	.16	.13	.13	.48	.44	.40
Primary aluminum	.19	.19	.15	.11	.10	.08	.37	.41	.38
Other primary nonferrous	.28	.24	.22	.15	.12	.11	.47	.45	.42
Fabricated metal products	1.76	1.64	1.63	.76	.66	.60	2.46	2.44	2.19
Cutlery and other hardware	.19	.19	.20	.07	.07	.07	.26	.30	.34
Fabricated structural metal	.54	.53	.60	.29	.25	.23	.87	.82	.61
Screw machine products	.13	.11	.10	.04	.03	.03	.16	.16	.14
Metal stamping	.29	.25	.25	.09	.08	.07	.34	.33	.33
Miscellaneous fabricated metal	.59	.54	.47	.24	.21	.18	.82	.82	.75
Machinery except electrical	2.51	2.45	2.61	2.27	2.18	2.38	8.31	8.80	9.21
Engines and turbines	.14	.14	.12	.13	.12	.09	.56	.59	.46
Farm machinery and equipment	.16	.15	.15	.09	.08	.08	.35	.36	.29
Construction machines	.37	.39	.40	.29	.28	.26	1.15	1.27	1.17
Metalworking machinery	.40	.36	.38	.25	.22	.22	.98	.98	.97
Office and accounting machines	.11	.07	.05	.14	.09	.06	.42	.30	.21
Electronic computing equipment	.23	.28	.39	.64	.74	1.01	1.75	2.13	3.08
Other machinery,exc electrical	1.08	1.03	1.08	.71	.63	.62	3.08	3.14	2.99
Electrical machinery	2.44	2.17	2.19	3.05	2.51	2.42	13.23	12.37	11.16
Household appliances	.23	.19	.18	.11	.09	.08	.43	.39	.35
Radio,tv communications equip	.80	.63	.57	1.31	.98	.98	5.91	4.99	4.55
Other electrical machinery	1.40	1.35	1.43	1.61	1.43	1.35	6.88	6.98	6.24
Transportation equipment	2.42	2.19	2.08	2.50	1.95	1.61	11.97	10.53	9.07
Motor vehicles and equipment	1.02	1.04	1.00	.58	.56	.50	2.17	2.40	2.20
Aircraft and parts	.84	.62	.45	1.58	1.11	.83	8.53	7.02	5.70
Ship,boat building and repair	.35	.30	.27	.26	.19	.18	1.03	.83	.86
Railroad equipment	.06	.06	.05	.03	.03	.02	.14	.15	.10
Mobile dwellings	.10	.11	.23	.01	.01	.04	.03	.04	.11
Cycles,misc transportation	.03	.04	.05	.01	.01	.02	.05	.07	.08
Professional,scientific instrs	.57	.59	.59	.68	.67	.63	2.36	2.48	2.15
Scientific instruments	.22	.20	.17	.31	.26	.20	1.27	1.23	.91
Optical,health serv supplies	.17	.21	.23	.15	.20	.20	.41	.55	.51
Photo equipment and supplies	.13	.13	.16	.20	.19	.21	.61	.65	.69
Watches and clock devices	.04	.03	.03	.01	.01	.00	.05	.04	.03
Miscellaneous manufacturing	.55	.49	.44	.21	.19	.16	.47	.46	.41
Nondurable goods	10.46	8.75	7.95	5.44	4.74	4.46	8.43	7.91	7.40

Table 2. Percent distribution of occupational employment by industry, 1970, 1978 and projected 1990

	Aero-nautical engineers			Chemical engineers			Civil engineers		
	1970	1978	1990	1970	1978	1990	1970	1978	1990
Total all industries	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Agriculture,forestry,fisheries	.00	.00	.00	.00	.00	.00	.78	1.25	1.15
Agriculture	.00	.00	.00	.00	.00	.00	.12	.21	.27
Agricultral production	.00	.00	.00	.00	.00	.00	.09	.18	.26
Horticultural services	.00	.00	.00	.00	.00	.00	.01	.02	.01
Forestry	.00	.00	.00	.00	.00	.00	.66	1.04	.87
Mining	.00	.00	.00	2.21	2.92	2.20	.71	.92	.97
Metal	.00	.00	.00	.12	.12	.10	.07	.07	.07
Coal	.00	.00	.00	.05	.08	.16	.07	.09	.17
Crude petroleum and natural gas	.00	.00	.00	1.71	2.38	1.66	.47	.67	.66
Nonmetallic mining and quarrying	.00	.00	.00	.32	.33	.26	.09	.08	.06
Construction	.00	.00	.00	1.95	2.13	1.74	42.94	37.50	37.42
General building contractors	.00	.00	.00	.16	.17	.19	4.92	4.62	4.34
General contractors,exc building	.00	.00	.00	1.79	1.95	1.55	35.19	29.83	30.16
Special trade contractors	.00	.00	.00	.00	.00	.00	2.82	3.04	2.91
Manufacturing	86.29	81.09	73.41	80.87	76.19	75.59	8.23	6.28	5.13
Durable goods	86.23	81.06	73.41	16.39	14.19	10.35	6.14	4.55	3.52
Ordnance	6.45	4.16	3.47	1.36	.70	.59	.54	.23	.15
Lumber and wood products	.00	.00	.00	.06	.04	.03	.13	.13	.19
Logging	.00	.00	.00	.02	.01	.01	.02	.01	.00
Sawmill,planing and mill work	.00	.00	.00	.00	.00	.00	.07	.08	.14
Miscellaneous wood products	.00	.00	.00	.03	.02	.02	.03	.03	.05
Furniture and fixtures	.00	.00	.00	.05	.12	.38	.02	.02	.04
Stone,clay,and glass products	.00	.00	.00	2.14	1.98	1.45	.65	.59	.54
Glass and glass products	.00	.00	.00	.43	.42	.36	.04	.04	.02
Cement,concrete,plaster	.00	.00	.00	.31	.30	.20	.51	.47	.42
Structural clay products	.00	.00	.00	.29	.15	.01	.02	.02	.02
Pottery and related products	.00	.00	.00	.23	.16	.03	.01	.00	.00
Miscellaneous nonmetalic,stone	.00	.00	.00	.87	.93	.83	.04	.05	.06
Primary metal industries	.00	.00	.00	2.05	1.93	1.80	.77	.60	.60
Blast furnaces,steel works	.00	.00	.00	.81	.71	.73	.49	.36	.36
Other primary steel	.00	.00	.00	.30	.30	.32	.10	.09	.13
Primary aluminum	.00	.00	.00	.35	.38	.30	.11	.09	.07
Other primary nonferrous	.00	.00	.00	.57	.53	.44	.05	.04	.03
Fabricated metal products	.00	.00	.00	.87	.76	.47	.98	.78	.43
Cutlery and other hardware	.00	.00	.00	.07	.10	.19	.02	.03	.04
Fabricated structural metal	.00	.00	.00	.28	.22	.06	.76	.63	.36
Screw machine products	.00	.00	.00	.01	.01	.01	.00	.00	.00
Metal stamping	.00	.00	.00	.13	.13	.11	.03	.02	.00
Miscellaneous fabricated metal	.00	.00	.00	.38	.29	.07	.15	.09	.01
Machinery except electrical	.38	.44	.29	2.20	1.99	1.03	.58	.39	.11
Engines and turbines	.17	.19	.09	.11	.08	.00	.03	.02	.00
Farm machinery and equipment	.00	.00	.00	.00	.00	.00	.03	.03	.04
Construction machines	.00	.00	.00	.18	.20	.16	.21	.14	.02
Metalworking machinery	.00	.00	.00	.06	.07	.06	.01	.01	.01
Office and accounting machines	.00	.00	.00	.15	.11	.07	.00	.00	.00
Electronic computing equipment	.03	.05	.05	.52	.54	.37	.03	.02	.00
Other machinery,exc electrical	.17	.19	.14	1.16	.97	.34	.25	.15	.02
Electrical machinery	1.32	1.16	.64	3.45	2.48	.74	.45	.25	.09
Household appliances	.00	.00	.00	.17	.11	.00	.00	.00	.00
Radio,tv communications equip	.93	.81	.56	.81	.48	.29	.21	.11	.07
Other electrical machinery	.38	.34	.08	2.47	1.88	.44	.23	.13	.01
Transportation equipment	77.16	74.11	67.74	2.32	2.05	1.57	1.80	1.33	1.07
Motor vehicles and equipment	.13	.17	.12	.53	.57	.44	.20	.21	.25
Aircraft and parts	76.78	73.62	67.40	1.61	1.30	.89	1.32	.94	.66
Ship,boat building and repair	.18	.25	.21	.13	.13	.21	.22	.14	.13
Railroad equipment	.02	.02	.00	.02	.02	.00	.03	.01	.00
Mobile dwellings	.00	.00	.00	.00	.00	.00	.02	.01	.00
Cycles,misc transportation	.03	.03	.00	.01	.01	.00	.00	.00	.00
Professional,scientific instrs	.60	.74	.58	1.56	1.79	1.92	.14	.14	.17
Scientific instruments	.54	.65	.50	.21	.21	.16	.04	.03	.02
Optical,health serv supplies	.04	.07	.07	.29	.42	.47	.02	.02	.03
Photo equipment and supplies	.01	.01	.00	1.04	1.14	1.28	.07	.07	.11
Watches and clock devices	.00	.00	.00	.01	.00	.00	.00	.00	.00
Miscellaneous manufacturing	.31	.43	.66	.29	.31	.32	.04	.05	.09
Nondurable goods	.05	.03	.00	64.47	62.00	65.24	2.09	1.72	1.61

Table 2. Percent distribution of occupational employment by industry, 1970, 1978 and projected 1990

	Sales engineers			Other engineers			Life and physical scientists		
	1970	1978	1990	1970	1970	1990	1970	1978	1990
Total all industries	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Agriculture,forestry,fisheries	.06	.06	.00	.25	.40	.39	2.03	2.65	3.04
Agriculture	.06	.06	.00	.14	.26	.35	1.55	1.82	2.34
Agricultral production	.00	.00	.00	.09	.22	.30	.57	.86	1.25
Services,except horticulture	.02	.02	.00	.02	.02	.02	.57	.47	.68
Horticultural services	.04	.04	.00	.01	.02	.02	.41	.49	.41
Forestry	.00	.00	.00	.11	.13	.04	.33	.58	.36
Fisheries	.00	.00	.00	.00	.00	.00	.14	.23	.33
Mining	1.14	1.75	2.14	.42	.54	.43	8.11	8.32	9.18
Metal	.02	.02	.02	.04	.04	.04	1.12	.80	.79
Coal	.00	.00	.00	.01	.02	.02	.12	.14	.21
Crude petroleum and natural gas	.98	1.58	1.94	.31	.43	.32	6.56	7.13	7.98
Nonmetallic mining and quarrying	.13	.15	.18	.04	.04	.03	.29	.23	.19
Construction	3.98	4.45	4.79	1.96	2.10	2.99	.93	.77	.90
General building contractors	.51	.50	.41	.18	.22	.29	.02	.03	.07
General contractors,exc building	.47	.45	.28	1.42	1.43	2.11	.90	.73	.83
Special trade contractors	2.99	3.50	4.09	.34	.44	.58	.00	.00	.00
Manufacturing	45.02	40.10	36.67	49.48	43.50	39.23	41.50	32.57	27.97
Durable goods	39.73	35.04	30.89	41.95	37.11	34.23	14.57	11.15	9.36
Ordnance	.15	.06	.02	5.30	2.51	1.77	1.02	.49	.48
Lumber and wood products	.23	.27	.49	.29	.27	.22	.09	.06	.04
Logging	.01	.00	.00	.02	.03	.03	.00	.00	.00
Sawmill,planing and mill work	.15	.22	.49	.20	.18	.13	.05	.02	.00
Miscellaneous wood products	.07	.05	.00	.06	.05	.05	.04	.03	.03
Furniture and fixtures	.28	.28	.40	.37	.34	.30	.03	.02	.02
Stone,clay,and glass products	1.52	1.47	1.46	1.58	1.36	.83	1.32	.96	.56
Glass and glass products	.13	.09	.00	.57	.48	.29	.31	.25	.20
Cement,concrete,plaster	.52	.53	.58	.42	.36	.20	.52	.36	.14
Structural clay products	.19	.17	.15	.04	.03	.01	.12	.07	.02
Pottery and related products	.08	.10	.17	.09	.08	.05	.04	.03	.04
Miscellaneous nonmetalic,stone	.59	.57	.55	.44	.40	.26	.31	.23	.14
Primary metal industries	2.73	2.42	2.59	1.07	.86	.69	3.82	2.71	2.16
Blast furnaces,steel works	.49	.37	.35	.41	.29	.19	1.88	1.20	.87
Other primary steel	1.11	1.02	1.25	.33	.27	.22	.67	.49	.39
Primary aluminum	.45	.44	.39	.10	.12	.15	.42	.36	.25
Other primary nonferrous	.68	.58	.59	.21	.17	.13	.03	.65	.64
Fabricated metal products	5.54	4.21	1.83	3.04	3.04	3.12	.89	.75	.68
Cutlery and other hardware	.19	.12	.02	.15	.15	.14	.06	.05	.02
Fabricated structural metal	2.54	2.03	.88	1.12	1.06	.86	.24	.21	.21
Screw machine products	.35	.19	.02	.15	.15	.18	.07	.05	.05
Metal stamping	.55	.28	.02	.37	.38	.49	.05	.04	.05
Miscellaneous fabricated metal	1.88	1.57	.88	1.23	1.28	1.43	.46	.38	.33
Machinery except electrical	14.05	12.97	11.15	12.25	12.35	12.73	1.40	1.23	1.30
Engines and turbines	.47	.23	.00	1.00	.99	.72	.12	.11	.10
Farm machinery and equipment	.19	.19	.20	.69	.65	.50	.05	.03	.02
Construction machines	1.87	1.80	1.19	2.01	2.05	1.60	.14	.13	.12
Metalworking machinery	3.28	2.95	2.30	1.29	1.35	1.68	.17	.15	.16
Office and accounting machines	.10	.05	.00	.66	.45	.37	.13	.07	.05
Electronic computing equipment	.56	.50	.80	2.49	2.75	3.60	.36	.35	.49
Other machinery,exc electrical	7.56	7.22	6.64	4.09	4.08	4.23	.41	.35	.32
Electrical machinery	9.39	8.22	8.44	7.69	6.99	6.98	2.12	1.74	1.52
Household appliances	.26	.16	.00	.31	.29	.35	.04	.03	.05
Radio,tv communications equip	1.60	.76	.71	3.15	2.68	2.87	.67	.52	.51
Other electrical machinery	7.52	7.29	7.73	4.21	4.02	3.74	1.39	1.18	.95
Transportation equipment	2.66	2.20	1.92	4.45	3.72	2.92	1.83	1.33	1.00
Motor vehicles and equipment	1.11	1.04	1.15	1.08	1.12	1.00	.38	.35	.33
Aircraft and parts	1.25	.92	.66	2.38	1.70	1.02	1.12	.78	.52
Ship,boat building and repair	.11	.10	.05	.58	.45	.39	.28	.14	.08
Railroad equipment	.13	.07	.00	.30	.31	.23	.02	.02	.03
Mobile dwellings	.04	.03	.03	.06	.07	.20	.00	.00	.01
Cycles,misc transportation	.01	.01	.01	.02	.04	.07	.00	.00	.01
Professional,scientific instrs	2.52	2.32	1.93	4.93	4.81	3.99	1.66	1.57	1.42
Scientific instruments	2.08	1.92	1.66	2.54	2.29	1.66	.39	.34	.26
Optical,health serv supplies	.30	.25	.05	.93	1.13	1.00	.41	.48	.43
Photo equipment and supplies	.08	.08	.10	1.33	1.28	1.26	.83	.72	.71
Watches and clock devices	.05	.05	.10	.12	.09	.06	.02	.01	.00
Miscellaneous manufacturing	.60	.57	.61	.94	.82	.63	.36	.25	.12
Nondurable goods	5.28	5.05	5.77	7.52	6.38	4.99	26.93	21.42	18.61

Table 2. Percent distribution of occupational employment by industry, 1970, 1978 and projected 1990

	Clerical workers			Stenogrphr, typists, secretaries			Legal secretaries		
	1970	1978	1990	1970	1978	1990	1970	1978	1990
Total all industries	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Agriculture,forestry,fisheries	.25	.34	.25	.30	.46	.32	.01	.00	.00
Agriculture	.22	.29	.21	.23	.37	.25	.01	.00	.00
Agricultral production	.07	.13	.08	.07	.19	.10	.01	.00	.00
Services,except horticulture	.11	.11	.08	.10	.11	.09	.00	.00	.00
Horticultural services	.03	.04	.03	.05	.06	.04	.00	.00	.00
Forestry	.03	.04	.02	.06	.07	.05	.00	.00	.00
Fisheries	.00	.00	.01	.00	.01	.01	.00	.00	.00
Mining	.41	.51	.39	.53	.65	.48	.46	.43	.39
Metal	.03	.03	.02	.05	.04	.03	.02	.01	.02
Coal	.04	.05	.05	.02	.03	.04	.00	.00	.01
Crude petroleum and natural gas	.27	.37	.27	.39	.52	.38	.42	.40	.34
Nonmetallic mining and quarrying	.06	.05	.03	.06	.05	.03	.00	.00	.00
Construction	1.97	2.05	1.95	2.31	2.30	2.08	.27	.16	.20
General building contractors	.40	.41	.38	.51	.49	.41	.06	.04	.05
General contractors,exc building	.69	.63	.67	.79	.69	.69	.17	.10	.14
Special trade contractors	.87	1.00	.89	1.00	1.11	.97	.03	.01	.00
Manufacturing	17.54	14.70	12.95	18.07	15.28	13.81	2.47	1.44	1.56
Durable goods	10.17	8.75	7.90	10.73	9.16	8.23	1.38	.82	.98
Ordnance	.33	.15	.12	.42	.18	.12	.10	.03	.03
Lumber and wood products	.23	.20	.17	.22	.21	.19	.01	.00	.00
Logging	.01	.01	.00	.00	.01	.00	.00	.00	.00
Sawmill,planing and mill work	.15	.14	.12	.15	.14	.13	.01	.00	.00
Miscellaneous wood products	.06	.05	.05	.06	.05	.05	.00	.00	.00
Furniture and fixtures	.31	.28	.30	.30	.29	.32	.01	.00	.00
Stone,clay,and glass products	.46	.39	.30	.50	.45	.38	.11	.07	.06
Glass and glass products	.12	.10	.08	.14	.13	.12	.04	.02	.02
Cement,concrete,plaster	.17	.14	.10	.17	.15	.12	.06	.03	.02
Structural clay products	.02	.01	.00	.03	.02	.01	.00	.00	.00
Pottery and related products	.02	.02	.01	.02	.02	.02	.00	.00	.00
Miscellaneous nonmetalic,stone	.11	.10	.08	.12	.11	.09	.00	.00	.00
Primary metal industries	.96	.74	.60	.83	.64	.52	.14	.07	.06
Blast furnaces,steel works	.44	.31	.24	.31	.22	.19	.09	.04	.03
Other primary steel	.23	.18	.15	.19	.15	.13	.02	.01	.01
Primary aluminum	.11	.10	.07	.12	.11	.07	.00	.00	.00
Other primary nonferrous	.18	.14	.13	.19	.15	.12	.02	.01	.01
Fabricated metal products	1.20	1.07	.96	1.20	1.08	.96	.08	.05	.08
Cutlery and other hardware	.15	.14	.12	.15	.13	.09	.01	.00	.01
Fabricated structural metal	.36	.33	.31	.35	.34	.36	.02	.02	.04
Screw machine products	.11	.09	.07	.10	.09	.07	.00	.00	.00
Metal stamping	.16	.14	.12	.16	.13	.11	.00	.00	.00
Miscellaneous fabricated metal	.41	.36	.31	.42	.37	.32	.04	.02	.03
Machinery except electrical	1.99	1.91	2.00	2.17	2.02	2.00	.21	.14	.18
Engines and turbines	.10	.10	.08	.09	.08	.06	.00	.00	.00
Farm machinery and equipment	.13	.11	.09	.11	.10	.09	.03	.03	.04
Construction machines	.31	.32	.31	.28	.28	.26	.05	.04	.04
Metalworking machinery	.27	.24	.25	.30	.27	.26	.01	.00	.00
Office and accounting machines	.12	.07	.05	.14	.09	.06	.01	.00	.00
Electronic computing equipment	.23	.28	.39	.31	.33	.43	.01	.01	.05
Other machinery,exc electrical	.81	.76	.79	.90	.83	.81	.08	.04	.04
Electrical machinery	1.95	1.67	1.54	2.27	1.87	1.61	.34	.24	.37
Household appliances	.15	.12	.10	.16	.12	.09	.00	.00	.00
Radio,tv communications equip	.73	.56	.44	.84	.61	.45	.16	.09	.11
Other electrical machinery	1.06	.99	1.00	1.26	1.13	1.06	.18	.14	.25
Transportation equipment	1.70	1.35	1.01	1.60	1.27	.97	.27	.14	.10
Motor vehicles and equipment	.60	.58	.47	.50	.49	.39	.07	.04	.03
Aircraft and parts	.78	.50	.25	.82	.55	.33	.18	.07	.02
Ship,boat building and repair	.21	.15	.13	.16	.12	.10	.01	.01	.03
Railroad equipment	.04	.04	.03	.03	.03	.02	.00	.00	.00
Mobile dwellings	.03	.04	.08	.04	.04	.08	.00	.00	.00
Cycles,misc transportation	.02	.02	.03	.02	.02	.02	.00	.00	.00
Professional,scientific instrs	.57	.56	.54	.70	.69	.65	.06	.05	.08
Scientific instruments	.22	.19	.15	.28	.24	.18	.00	.00	.00
Optical,health serv supplies	.16	.20	.21	.20	.24	.24	.03	.03	.05
Photo equipment and supplies	.15	.14	.15	.18	.17	.21	.03	.01	.02
Watches and clock devices	.03	.02	.01	.03	.02	.01	.00	.00	.00
Miscellaneous manufacturing	.42	.36	.33	.47	.42	.44	.00	.00	.00
Nondurable goods	7.37	5.95	5.04	7.34	6.12	5.58	1.09	.61	.57

Table 3. National nonagricultural employment of wage and salary workers by industry, 1970 and projected 1990

(In thousands)

Industry	1967 Standard Industrial Classification code	1970	1990
Total nonagricultural employment		70,616	107,978
Mining	10-14	622	1,038
Metal mining	10	93.9	113.0
Iron ores	101	25.9	19.0
Copper ores	102	36.7	57.0
Coal mining	11-12	144.5	339.0
Bituminous coal and lignite mining	12	138.9	335.4
Oil and gas extraction	13	269.6	475.0
Crude petroleum and natural gas fields	131,2	144.1	190.0
Oil and gas field services	138	125.5	285.0
Nonmetallic minerals, except fuels	14	114.1	111.0
Crushed and broken stone	142	40.3	38.4
Sand and gravel	144	36.8	35.9
Contract construction	15-17	3,345	4,925
General building contractors	15	1,003.1	1,428.6
Heavy construction contractors	16	705.2	972.8
Highway and street construction	161	324.7	395.0
Heavy construction, nec	162	380.5	577.8
Special trade contractors	17	1,636.5	2,523.6
Plumbing, heating, air conditioning	171	404.6	628.7
Painting, paper hanging, decorating	172	124.8	147.1
Electrical work	173	296.3	496.2
Masonry, stonework, and plastering	174	209.8	247.9
Roofing and sheet-metal work	176	113.7	164.2
Manufacturing	19-39	19,369	23,585.0
Durable goods	19,24,25,32-39	11,198	14,502.0
Ordnance and accessories	19	242.1	153.0
Ammunition, except for small arms	192	170.0	103.0
Complete guided missiles	1925	99.0	86.0
Ammunition, except for small arms, nec	1929	71.0	17.0
Lumber and wood products	24	572.5	691.0
Logging camps and logging contractors	241	71.9	64.0
Sawmills and planing mills	242	213.8	175.0
Sawmills and planing mills, general	2421	181.3	141.7
Millwork, plywood, and related products	243	167.1	283.9
Millwork	2431	72.2	121.7
Veneer and plywood	2432	70.2	104.4
Wooden containers	244	33.2	14.0
Wooden boxes, shook, and crates	2441,2	26.7	10.0
Miscellaneous wood products	2512	86.4	154.1
Furniture and fixtures	25	459.9	676.0
Household furniture	251	320.7	497.0
Wood household furniture	2511	161.5	248.1
Upholstered household furniture	2512	87.3	154.8
Mattresses and bedsprings	2515	36.8	43.5
Office furniture	252	37.7	56.6
Partitions and fixtures	254	51.1	69.8
Other furniture and fixtures	253,9	50.4	52.6
Stone, clay, and glass products	32	638.5	716.0
Flat glass	321	24.3	16.3
Glass and glassware, pressed or blown	322	132.2	155.8
Glass containers	3221	76.8	88.8
Pressed and blown glass, nec	3229	55.4	67.2

Table 3. Continued—National nonagricultural employment of wage and salary workers by industry, 1970 and projected 1990
(In thousands)

Industry	1967 Standard Industrial Classification code	1970	1990
Cement hydraulic	324	33.3	19.2
Structural clay products	325	58.5	32.0
Brick and structural clay tile	3251	25.8	14.5
Pottery and related products	326	43.3	42.0
Concrete, gypsum, and plaster products	327	185.5	241.8
Other stone and nometallic mineral products	328,9	133.0	156.0
Abrasive products	3291	26.2	27.9
Primary metal industries	33	1,314.8	1,356.0
Blast furnace and basic steel products	331	629.4	553.0
Blast furnaces and steel mills	3312	549.3	474.4
Iron and steel foundries	332	228.0	259.9
Gray iron foundries	3321	139.6	173.8
Malleable iron foundries	3322	22.6	20.3
Steel foundries	3323	65.8	85.8
Nonferrous metals	333,4	89.5	103.1
Primary aluminum	3334	31.4	41.8
Nonferrous rolling and drawing	335	213.1	236.3
Copper rolling and drawing	3351	44.0	29.3
Aluminum rolling and drawing	3352	69.6	72.3
Nonferrous wire drawing and insulating	3357	77.7	110.7
Nonferrous foundries	336	83.0	108.6
Aluminum castings	3361	42.9	56.9
Other nonferrous castings	3362,9	40.1	51.7
Miscellaneous primary metal products	339	71.7	95.0
Iron and steel forgings	3391	47.0	57.1
Fabricated metal products	34	1,379.9	1,874.0
Metal cans	341	73.2	73.8
Cutlery hand tools, and hardware	342	150.9	229.0
Cutlery and hand tools, including saws	3421,3,5	63.2	107.4
Hardware, nec	3429	87.8	121.6
Plumbing and heating, except electric	343	81.9	77.0
Sanitary ware and plumbers brass goods	3431,2	37.5	38.3
Heating equipment, except electric	3433	44.4	38.7
Fabricated structural metal products	344	426.5	693.0
Fabricated structural steel	3441	110.9	124.7
Metal doors sash, and trim	3442	66.7	107.8
Fabricated plate work (boiler shops)	3443	117.8	195.7
Sheet metal work	3444	81.3	150.8
Architectural and misc metal work	3446,9	49.7	114.0
Screw machine products bolts, etc	345	104.7	114.0
Screw machine products	3451	46.4	54.4
Bolts nuts, rivets, and washers	3452	58.3	59.6
Metal stampings	346	232.5	293.0
Metal services nec	347	84.6	127.7
Misc fabricated wire products	348	66.8	65.9
Misc fabricated metal products	349	158.8	200.6
Valves pipe and pipe fittings	3494,8	96.3	129.7
Machinery, except electrical	35	1,976.9	2,997.0
Engines and turbines	351	111.4	145.0
Steam engines and turbines	3511	39.9	44.4
Internal combustion engines nec	3519	71.5	100.6
Farm machinery	352	129.5	182.0
Construction and related machinery	353	296.0	472.0
Construction and mining machinery	3531,2	157.8	238.0
Oil field machinery	3533	45.9	96.0
Conveyors, hoists, cranes, monorails	3535,6	42.6	66.9
Industrial trucks and tractors	3537	33.4	53.9
Metalworking machinery	354	315.2	436.0
Machine tools, metal cutting types	3541	67.8	73.2
Special dies, tools, jigs & fixtures	3544	117.7	177.4
Machine tool accessories	3545	54.3	79.2
Misc metalworking machinery	3542,8	75.4	106.2
Special industry machinery	355	197.8	230.0
Food products machinery	3551	43.0	53.6
Textile machinery	3552	38.6	39.8
Printing trades machinery	3555	32.2	36.3

Table 4. Total national employment by industry, 1970, 1978, and projected 1990

(In thousands)

Industry	1967 Standard Industrial Classification code	1970	1978	1990
Total all industries		78,627.7	94,372.6	114,000.3
Agriculture, forestry, and fisheries		3,561.1	3,484.7	3,067.9
Agriculture		3,463.4	3,334.8	2,934.0
Agricultural production	01	3,135.5	2,845.8	2,384.8
Services, except horticulture	07 except 0713, 073	170.5	241.9	303.8
Horticultural services	073	157.4	247.1	245.4
Forestry	08	53.4	79.5	71.1
Fisheries	09	44.3	70.4	62.8
Mining		634.0	884.8	1,059.2
Metal mining	10	93.7	94.6	113.1
Coal mining	11,12	144.8	212.7	339.8
Crude petroleum and natural gas	13	279.2	453.3	491.0
Nonmetallic mining and quarrying	14	118.3	124.2	115.5
Construction		4,673.3	5,907.9	6,897.8
General building contractors	15	1,138.0	1,466.4	1,717.9
General contractors exc building	16	1,401.9	1,552.3	1,925.3
Special trade contractors	17	2,133.4	2,889.2	3,254.6
Manufacturing		19,635.9	20,611.6	23,617.1
Durable goods		11,410.7	12,347.6	14,550.0
Ordnance	19	296.3	172.3	172.9
Lumber and wood products	24	620.5	685.4	739.9
Logging	241	110.8	131.2	104.3
Sawmill, planing and mill work	242,243	388.3	422.7	465.9
Miscellaneous wood products	244,9	121.4	131.5	169.7
Furniture and fixtures	25	464.3	522.1	674.4
Stone, clay, and glass products	32	644.1	697.6	710.4
Glass and glass products	321-3	185.2	202.2	221.6
Cement, concrete, plaster	324,7	221.8	245.1	260.1
Structural clay products	325	59.1	51.3	31.9
Pottery and related products	326	43.9	46.9	42.3
Miscellaneous nonmetallic stone	328,9	134.1	152.1	154.4
Primary metal industries		1303.4	1255.2	1345.5
Blast furnaces, steel works	3312, 3	556.0	480.6	478.5
Other primary steel	3315-7, 332,3391 Part 3399	367.7	366.6	427.1
Primary aluminum	3334, pt 334, 3352, 3361, pt 3392,9	156.4	179.3	181.2
Other primary nonferrous	3331-3,9, pt 334, 3351,6,7, 3362,9, pt 3392 and 9	223.2	228.7	258.7
Fabricated metal products		1,387.4	1,547.7	1,868.0
Cutlery and other hardware	342	151.6	180.0	227.6
Fabricated structural metal	344	431.4	502.3	692.8
Screw machine products	345	104.8	108.7	113.5
Metal stamping	346	232.3	244.9	291.0
Miscellaneous fabricated metal	341,3,7-9	467.2	511.8	543.2
Machinery except electrical		1,978.5	2,316.4	2,980.4
Engines and turbines	351	110.0	132.5	142.8
Farm machinery and equipment	352	128.6	149.6	179.7
Construction machines	353	293.3	370.8	466.7
Metalworking machinery	354	317.8	348.4	436.8
Office and accounting machines	357 exc 3	90.9	72.1	65.9
Electronic computing equipment	3573	187.9	268.0	450.8
Other machinery, except electrical	355,6,8,9	849.9	975.1	1,238.0
Electrical machinery		1,919.6	2,056.4	2,500.5
Household appliances	363	184.7	182.7	213.0
Radio, TV, communication equipment	365,6	630.3	598.5	657.2
Other electrical machinery	361,2,4,7	1,104.5	1,275.2	1,630.3

Table 4. Continued—Total national employment by industry, 1970, 1978, and projected 1990

[illegible]

Industry	1967 Standard Industrial Classification code	1970	1978	1990
Transportation equipment		1,907.1	2,066.4	2,371.5
Motor vehicles and equipment	371	804.6	981.6	1,145.2
Aircraft and parts	372	665.9	586.6	513.2
Ship, boat building and repair	373	275.6	282.8	314.3
Railroad equipment	374	50.6	62.2	63.9
Mobile dwellings	3791	85.2	110.8	269.0
Cycles misc transportation	375,3799	25.1	42.4	65.9
Professional scientific instruments		453.9	564.5	683.2
Scientific instruments	381.2	177.3	196.3	196.0
Optical, health serv supplies	383,4,5	136.4	206.8	266.6
Photo equipment and supplies	386	108.9	131.1	184.3
Watches and clock devices	387	31.3	30.3	36.3
Miscellaneous manufacturing	39	435.5	463.8	503.2
Nondurable goods		8,225.2	8,264.0	9,067.1
Food and kindred products		1,784.2	1,707.7	1,735.9
Meat products	201	344.2	350.6	355.4
Dairy products	202	244.6	186.7	137.3
Canning and preserving	203	284.1	300.1	363.0
Grainmill products	204,0713	138.1	146.2	156.6
Bakery products	205	273.6	232.7	204.8
Confectionery products	207	82.7	77.5	80.2
Beverages	208	236.1	227.8	234.4
Miscellaneous food preparation	206,9	180.7	186.1	204.2
Tobacco manufacturing	21	81.7	67.3	57.8
Textile mill products		978.5	898.9	1,054.9
Knitting mills	225	247.3	235.7	333.9
Dyeing, finishing textiles	226	83.2	78.7	76.9
Floor coverings	227	57.1	61.4	103.4
Yarn and fabric mills	221-4,8	515.9	453.1	458.2
Miscellaneous textile mills	229	74.9	70.0	82.5
Apparel and textile products		1,392.3	1,342.3	1,557.0
Apparel and accessories	231-8	1,224.5	1,146.8	1,320.3
Miscellaneous fabricated textiles	239	167.8	195.5	236.7
Paper and allied products		707.4	696.2	790.4
Pulp, paper, paperboard mills	261-3,6	291.6	265.1	255.7
Paperboard containers, boxes	265	226.1	212.9	266.5
Miscellaneous paper and pulp	264	189.7	218.2	268.1
Printing and publishing		1,161.1	1,259.3	1,342.7
Newspaper publishing printing	271	417.2	459.5	531.0
Other printing, exc newspapers	272-9	743.9	799.8	811.7
Chemicals and allied products		1,031.3	1,078.1	1333.2
Industrial chemicals	281	318.9	325.6	393.5
Plastics and synthetics	282 exc. 2823,4	101.7	96.2	108.9
Synthetic fibers	2823,4	108.6	116.9	180.8
Drugs and medicines	283	143.1	185.4	220.7
Soaps and cosmetics	284	124.8	134.5	166.3
Paints and varnishes	285	68.4	72.2	92.0
Agricultural chemicals	287	55.0	61.0	57.1
Miscellaneous chemicals	286,9	110.7	86.3	113.9
Petroleum and coal products		190.1	208.4	177.8
Petroleum refining	291	153.5	164.5	121.5
Misc petroleum, coal products	295,9	36.6	43.9	56.3
Rubber and miscellaneous plastics		577.8	747.8	802.7
Rubber	301-3,6	288.1	295.9	339.1
Miscellaneous plastics	307	289.7	451.9	463.7
Leather products		320.7	258.2	214.7
Leather tanning and finishing	311	26.1	22.5	13.7
Footwear except rubber	313,4	225.5	171.7	132.1
All other leather products	312,5-7,9	69.1	64.0	69.0
Transportation other public utilities		5,025.8	5,749.8	6,332.1

Table 5. National 1978 employment, projected 1990 requirements, and average annual openings, 1978-90, by occupation

(Numbers in thousands)

Occupation	1978 employment	1990 employment	Percent change 1978-90	Average annual openings 1978-90		
				Total	Employment change	Replacement needs[1]
Total all occupations	94,372.6	114,000.3	20.8	5,177.4	1,635.6	3,541.8
Professional and technical	14,244.6	16,854.2	18.3	675.8	217.5	458.3
Engineers, technical	1,157.1	1,418.0	22.5	47.2	21.7	25.5
Aeronautical	58.0	70.0	20.7	1.9	1.0	.9
Chemical	53.0	63.6	20.0	1.8	.9	9
Civil	155.0	190.3	22.8	7.8	2.9	4.9
Electrical	300.0	364.4	21.5	10.5	5.4	5.1
Industrial	185.0	233.1	26.0	8.0	4.0	4.0
Mechanical	195.0	232.2	19.1	7.5	3.1	4.4
Metallurgical	16.5	21.3	29.1	.8	.4	4
Mining	6.0	9.5	58.3	.6	.3	.3
Petroleum	17.0	23.4	37.6	.8	5	.3
Sales	34.0	32.0	-5.9	.6	-.2	8
Other engineers	137.6	178.2	29.5	7.0	3.4	3.6
Life and physical scientists	280.6	349.8	24.7	12.4	5.8	6.6
Agricultural	19.7	26.0	32.0	1.2	.5	.7
Atmospheric and space	12.5	14.0	12.0	.4	.1	.3
Biological	62.2	79.0	27.0	2.9	1.4	1.5
Chemists	122.5	151.3	23.5	5.2	2.4	2.8
Geologists	31.0	43.8	41.3	1.9	1.1	.8
Marine	5.2	6.3	21.2	2	1	.1
Physicists and astronomers	24.9	26.4	6.0	4	.1	.3
Other life and physical scientists	2.6	3.0	15.4	1	.0	.1
Mathematical specialists	42.4	54.3	28.1	2.3	1.0	1.3
Actuaries	9.0	11.9	32.2	.5	2	.3
Mathematicians	10.4	11.3	8.7	.3	1	.2
Statisticians	23.0	31.1	35.2	1.5	.7	.8
Engineering and science technicians	967.1	1,241.0	28.3	40.4	22.8	17.6
Agricultural, biological, exc health	44.7	55.5	24.2	2.2	.9	1.3
Chemical technicans	88.2	110.6	25.4	3.5	1.9	1.6
Drafters	296.0	393.0	32.8	13.4	8.1	5.3
Electrical and electronic	196.1	253.4	29.2	7.4	4.8	2.6
Industrial engineering	27.6	35.7	29.3	1.3	.7	.6
Mathematical technicians	1.2	1.9	58.3	.1	.1	.0
Mechanical engineering	15.1	19.9	31.8	7	4	.3
Surveyors	73.8	87.0	17.9	2.6	1.1	1.5
Other engineering and science technicians	224.4	284.0	26.6	9.4	5.0	4.4
Medical workers, exc technicians	1,915.1	2,688.5	40.4	140.5	64.4	76.1
Chiropractors	18.0	21.1	17.2	1.5	3	1.2
Dentists	119.3	155.0	29.9	5.5	3.0	2.5
Dietitians	35.0	50.0	42.9	3.1	1.3	1.8
Optometrists	20.9	26.3	25.8	1.6	5	1.1
Pharmacists	135.0	185.0	37.0	12.6	4.2	8.4
Physicians and osteopaths	375.6	504.0	34.2	16.8	10.7	6.1
Podiatrists	8.1	12.4	53.1	.9	.4	5
Registered nurses	1,001.7	1,455.0	45.3	85.0	37.8	47.2
Therapists	164.4	230.0	39.9	11.4	5.5	5.9
Veterinarians	29.6	39.8	34.5	1.8	9	.9
Other medical and health workers	7.6	9.8	28.9	7	2	5
Health technologists, technicians	510.2	670.8	31.5	30.6	13.4	17.2
Clinical lab technologists, tech	217.9	265.0	21.6	10.6	3.9	6.7
Dental hygienists	35.0	65.0	85.7	4.3	2.5	1.8
Health record technologists, technicians	15.6	20.0	28.2	1.2	4	.8
Radiologic technologists, technicians	103.8	140.0	34.9	6.6	3.0	3.6
Therapy assistants	7.3	10.0	37.0	5	2	3
Other health technicians	130.6	170.8	30.8	7.4	3.4	4.0

Table 5. Continued—National 1978 employment, projected 1990 requirements, and average annual openings, 1978-90, by occupation

(Numbers in thousands)

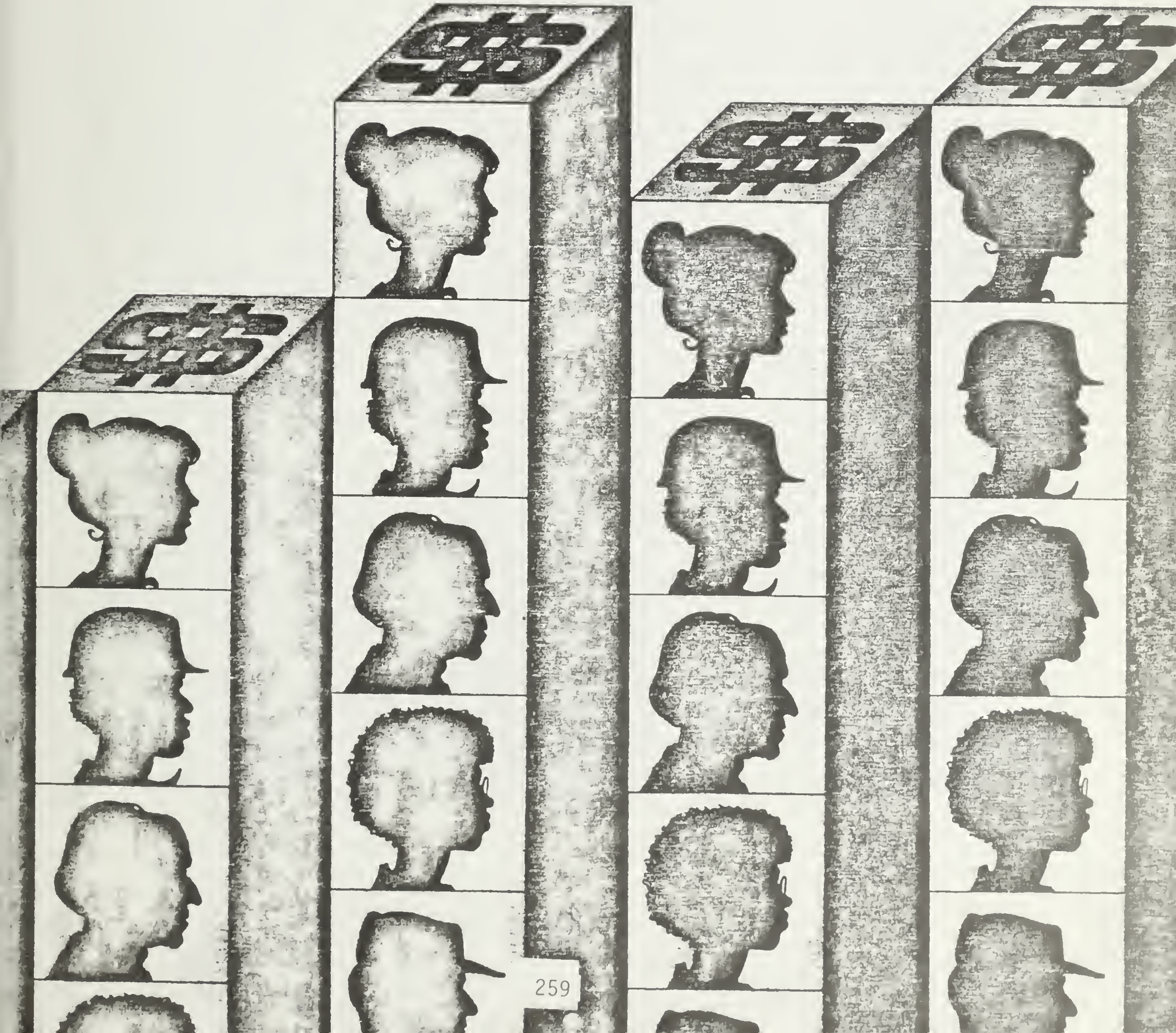
Occupation	1978 employment	1990 employment	Percent change 1978-90	Average annual openings 1978-90		
				Total	Employment change	Replacement needs[1]
Technicians, except health	217.1	283.3	30.5	10.1	5.5	4.6
Airplane pilots	71.6	99.3	38.7	3.2	2.3	9
Air traffic controllers	27.2	33.2	22.1	9	5	4
Embalmers	5.0	5.0	0.0	2	0	2
Flight engineers	5.2	6.7	28.8	2	1	1
Radio operators	44.3	56.6	27.8	2.7	1.0	1.7
Tool programmers, numerical	3.8	5.8	52.6	.3	2	1
Other technicians except health	60.0	76.7	27.8	2.8	1.4	1.4
Computer specialists	435.8	570.0	30.8	16.6	11.2	5.4
Computer programmers	247.0	320.0	29.6	9.2	6.1	3.1
Computer systems analysts	157.7	217.0	37.6	6.8	4.9	1.9
Other computer specialists	31.1	33.0	6.1	.5	2	.3
Social scientists	264.3	359.6	36.1	14.8	7.9	6.9
Economists	122.5	170.0	38.8	7.3	4.0	3.3
Political scientists	2.9	4.8	65.5	.3	.2	.1
Psychologists	110.0	148.0	34.5	6.0	3.2	2.8
Sociologists	3.9	6.2	59.0	.3	.2	.1
Urban and regional planners	17.0	22.0	29.4	.7	4	.3
Other social scientists	8.0	8.6	7.5	.4	1	3
Teachers	3,690.0	3,572.9	-3.2	111.9	-9.8	121.7
Adult education	84.1	95.0	13.0	3.8	9	2.7
College and university	583.2	500.0	-14.3	6.7	-6.9	13.6
Elementary school	1,355.3	1,580.4	16.6	76.3	18.8	57.5
Preschool and kindergarten	237.6	282.0	18.7	12.8	3.7	8.9
Secondary school	1,197.4	880.0	-28.5	1.2	-26.5	27.7
Other teachers	232.4	235.4	1.3	11.5	3	11.2
Writers, artists, entertainers	1,246.5	1,457.2	16.9	58.1	17.6	40.5
Actors	13.4	18.0	34.3	8	4	4
Athletes and kindred workers	106.6	115.2	8.1	3.5	7	2.8
Authors	43.4	50.0	15.2	2.3	6	1.7
Dancers	8.0	11.0	37.5	6	3	.3
Designers	167.1	184.0	10.1	5.8	1.4	4.4
Editors and reporters	190.9	240.0	25.7	11.6	4.1	7.5
Musicians and composers	154.6	208.0	34.5	10.1	4.5	5.6
Painters and sculptors	193.0	205.5	6.5	7.2	1.0	6.2
Photographers	93.0	107.0	15.1	3.9	1.2	2.7
Public relations specialists	131.0	163.0	24.4	7.6	2.7	4.9
Radio and TV announcers	27.0	33.5	24.1	8	5	.3
Other writers, artists, entertainers	118.5	122.0	3.0	3.8	3	3.5
Other professional and technical	3,518.4	4,188.9	19.1	190.9	55.9	135.0
Accountants	1,011.8	1,265.0	25.0	58.7	21.1	37.8
Architects	71.6	114.0	59.2	6.5	3.5	3.0
Archivists and curators	10.4	12.0	15.4	6	1	.5
Clergy	262.0	276.0	5.3	14.1	1.2	12.9
Religious workers, except clergy	60.0	75.0	25.0	5.1	1.3	3.8
Farm management advisors	9.3	11.0	18.3	3	.1	.2
Foresters and conservationsts	60.2	70.0	16.3	2.5	8	1.7
Home management advisors	5.2	5.4	3.8	2	.0	2
Judges	18.4	20.0	8.7	2.1	1	2.0
Lawyers	487.0	600.0	23.2	35.8	9.4	26.4
Librarians	147.4	160.0	8.5	7.7	1.1	6.8
Operations and systems research	121.2	139.0	14.7	3.5	1.5	2.0
Personnel, labor relations workers	420.3	473.0	12.5	16.8	4.4	11.4
Other research workers	126.6	135.0	6.6	3.4	7	2.7
Recreation workers	130.1	164.4	26.4	7.0	2.9	4.1
Social workers	399.5	475.0	18.9	20.9	6.3	14.6
Vocation, education counselors	177.5	194.0	9.3	6.6	1.4	5.2
Managers, officials, proprietors	10,105.0	12,203.0	20.8	594.7	174.8	419.9

EMPLOYMENT AND EARNINGS

June 1983

U.S. Department of Labor
Bureau of Labor Statistics

In this issue:
Establishment data
adjusted to new
benchmarks



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ESTABLISHMENT DATA
EMPLOYMENT

B-2. Employees on nonagricultural payrolls by industry

[In thousands]

1972 SIC Code	Industry	All employees					Production workers[1]				
		Apr. 1982	May 1982	Mar. 1983	Apr. 1983P	May 1983P	Apr. 1982	May 1982	Mar. 1983	Apr. 1983P	May 1983P
–	TOTAL	89,938	90,407	88,172	89,005	89,873	-	-	-	-	-
–	PRIVATE SECTOR	73,764	74,228	72,121	72,971	73,806	59,521	59,989	57,989	58,780	59,588
–	MINING	1,197	1,179	996	991	1,006	881	863	699	696	711
10	METAL MINING	87.6	79.7	60.8	61.2	-	65.2	58.6	44.2	44.5	-
101	Iron ores	18.3	17.2	8.5	8.4	-	13.5	13.0	5.6	5.5	-
102	Copper ores	29.8	24.4	19.7	19.9	-	22.5	17.6	14.4	14.5	-
11, 12	COAL MINING	254.9	251.1	204.5	202.6	-	210.4	206.7	163.8	162.1	-
12	BITUMINOUS COAL AND LIGNITE MINING	251.5	247.6	201.8	199.9	-	207.3	203.6	161.4	159.8	-
13	OIL AND GAS EXTRACTION	744.0	734.3	628.8	619.2	-	521.7	511.1	415.5	407.8	-
131, 2	Crude petroleum, natural gas, and natural gas liquids	273.1	276.0	279.6	278.2	-	123.4	126.0	129.4	129.3	-
138	Oil and gas field services	470.9	458.3	349.2	341.0	-	398.3	385.1	286.1	278.5	-
14	NONMETALLIC MINERALS, EXCEPT FUELS	110.4	113.6	101.6	108.3	-	83.6	86.8	75.9	81.9	-
142	Crushed and broken stone	35.1	37.3	33.9	37.3	-	27.9	30.1	26.0	29.2	-
144	Sand and gravel	31.7	32.6	29.2	31.9	-	-	-	-	-	-
147	Chemical and fertilizer minerals	24.3	24.1	20.5	20.3	-	-	-	-	-	-
–	CONSTRUCTION	3,800	3,998	3,453	3,649	3,893	2,894	3,088	2,566	2,752	2,984
15	GENERAL BUILDING CONTRACTORS	965.5	1,007.6	891.4	926.2	-	711.3	751.9	636.4	668.1	-
152	Residential building construction	422.3	451.4	406.6	428.5	-	295.7	323.0	277.6	297.4	-
153	Operative builders	48.4	48.6	48.5	52.2	-	24.5	24.7	24.9	28.1	-
154	Nonresidential building construction	494.8	507.6	436.3	445.5	-	391.1	404.2	333.9	342.6	-
16	HEAVY CONSTRUCTION CONTRACTORS	805.4	859.0	702.1	757.3	-	632.2	686.2	537.8	592.6	-
161	Highway and street construction	196.5	234.0	157.8	191.5	-	159.4	196.0	122.3	154.8	-
162	Heavy construction, except highway	608.9	625.0	544.3	565.8	-	472.8	490.2	415.5	437.8	-
17	SPECIAL TRADE CONTRACTORS	2,029.1	2,131.3	1,859.9	1,965.6	-	1,550.3	1,649.4	1,391.3	1,490.8	-
171	Plumbing, heating, air conditioning	489.2	496.6	464.3	468.0	-	353.6	360.4	329.5	333.1	-
172	Painting, paper hanging, decorating	117.2	127.7	103.9	112.3	-	94.3	105.7	82.6	90.5	-
173	Electrical work	398.9	405.7	376.4	376.0	-	303.7	309.5	280.1	280.2	-
174	Masonry, stonework, and plastering	293.6	310.0	274.7	292.3	-	246.3	261.8	227.7	243.2	-
175	Carpentering and flooring	98.5	104.5	100.0	105.2	-	70.6	77.1	73.4	78.1	-
176	Roofing and sheet metal work	148.1	153.8	129.8	143.4	-	116.5	121.6	98.6	111.5	-
–	MANUFACTURING	19,080	19,049	18,166	18,295	18,455	12,979	12,968	12,241	12,370	12,544
24, 25, 32-39	DURABLE GOODS	11,348	11,305	10,590	10,689	10,806	7,562	7,539	6,944	7,039	7,163
20-23, 26-31	NONDURABLE GOODS	7,732	7,744	7,576	7,606	7,649	5,417	5,429	5,297	5,331	5,381
	DURABLE GOODS										
24	LUMBER AND WOOD PRODUCTS	593.1	604.6	620.5	640.0	664.2	484.0	494.4	511.8	529.3	552.5
241	Logging camps and logging contractors	69.0	73.3	72.4	74.6	-	51.1	55.1	55.3	57.2	-
242	Sawmills and planing mills	178.1	180.4	186.2	190.5	-	156.1	158.4	163.8	167.9	-
2421	Sawmills and planing mills, general	149.0	151.2	155.7	159.7	-	131.2	133.2	137.3	141.2	-
2426	Hardwood dimension and flooring	25.3	25.5	26.6	26.8	-	21.5	21.9	23.0	23.2	-
243	Millwork, plywood, and structural members	171.9	175.4	188.5	193.8	-	138.5	141.5	154.2	159.2	-
2431	Millwork	61.6	64.1	72.6	75.2	-	47.8	49.9	57.8	60.3	-
2434	Wood kitchen cabinets	41.7	42.6	42.2	43.8	-	32.6	33.4	33.0	34.4	-
2435	Hardwood veneer and plywood	22.5	22.5	21.9	21.8	-	19.6	19.6	19.0	19.0	-
2436	Softwood veneer and plywood	33.9	33.3	37.5	38.1	-	29.6	29.0	33.4	34.0	-
244	Wood containers	38.9	38.9	37.5	38.7	-	32.9	32.9	31.3	32.4	-
245	Wood buildings and mobile homes	61.5	63.3	63.7	68.8	-	44.2	45.9	47.5	51.7	-
2451	Mobile homes	45.2	46.3	46.1	49.9	-	34.5	35.5	36.0	39.1	-
249	Miscellaneous wood products	73.7	73.3	72.2	73.6	-	61.2	60.6	59.7	60.9	-
25	FURNITURE AND FIXTURES	435.1	431.3	431.3	439.6	441.7	344.0	340.8	340.4	347.4	350.0
251	Household furniture	272.8	269.6	271.0	276.0	-	224.6	222.1	223.1	227.9	-
2511	Wood household furniture	122.5	121.2	120.2	122.5	-	105.2	104.0	103.2	105.4	-
2512	Upholstered household furniture	82.8	83.3	85.2	87.1	-	66.1	66.7	68.1	70.0	-
2514	Metal household furniture	27.8	26.1	29.4	29.4	-	22.3	20.9	24.0	24.0	-
2515	Mattresses and bedsprings	26.0	28.0	27.8	28.3	-	20.9	20.9	20.9	21.3	-
252	Office furniture	54.0	53.9	53.5	53.8	-	41.7	41.5	40.7	40.9	-
253	Public building and related furniture	21.9	21.3	20.5	20.6	-	16.3	15.8	15.0	15.0	-
254	Partitions and fixtures	57.6	57.4	54.9	57.3	-	41.9	41.8	40.3	42.0	-
259	Miscellaneous furniture and fixtures	28.8	29.1	31.4	31.9	-	19.5	19.6	21.3	21.6	-

B-2. Employees on nonagricultural payrolls by industry — Continued

[In thousands]

1972 SIC Code	Industry	All employees					Production workers[1]				
		Apr. 1982	May 1982	Mar. 1983	Apr. 1983P	May 1983P	Apr. 1982	May 1982	Mar. 1983	Apr. 1983P	May 1983P
32	**STONE, CLAY, AND GLASS PRODUCTS**	580.4	588.5	541.9	559.9	574.3	438.0	445.9	408.2	424.2	438.7
321	Flat glass	16.3	16.4	16.9	16.8	-	12.5	12.5	13.3	13.2	-
322	Glass and glassware, pressed or blown	111.2	110.8	102.6	102.7	-	92.7	92.4	85.7	85.9	-
3221	Glass containers	61.9	62.5	57.4	56.8	-	54.2	54.8	50.3	49.6	-
3229	Pressed and blown glass, nec	49.3	48.3	45.2	45.9	-	38.5	37.6	35.4	36.3	-
323	Products of purchased glass	41.2	41.6	41.0	41.7	-	27.3	27.6	27.4	27.9	-
324	Cement, hydraulic	27.4	27.7	24.6	25.5	-	21.6	21.9	19.1	19.9	-
325	Structural clay products	33.8	34.4	33.2	34.7	-	24.7	25.2	24.6	26.2	-
326	Pottery and related products	39.6	39.4	36.5	38.1	-	32.0	32.0	28.8	30.0	-
327	Concrete, gypsum, and plaster products	177.6	185.6	166.7	178.5	-	133.2	141.0	124.0	134.8	-
3271	Concrete block and brick	16.7	17.7	16.8	17.6	-	11.0	12.0	11.1	11.8	-
3272	Concrete products, nec	60.3	61.2	54.7	57.2	-	44.0	45.2	39.5	41.7	-
3273	Ready mixed concrete	82.9	89.1	77.9	86.2	-	64.0	69.7	59.7	67.4	-
329	Misc. nonmetallic mineral products	122.6	121.7	110.3	111.6	-	85.4	84.7	77.3	78.3	-
3291	Abrasive products	24.4	24.1	21.3	21.4	-	15.5	15.4	13.6	13.7	-
3292	Asbestos products	13.5	13.4	12.6	12.9	-	10.0	9.9	9.2	9.5	-
3296	Mineral wool	27.0	27.0	25.4	25.4	-	-	-	-	-	-
33	**PRIMARY METAL INDUSTRIES**	981.5	952.5	820.8	829.6	841.7	732.0	708.2	606.8	614.9	627.6
331	Blast furnace and basic steel products	428.8	413.3	332.6	337.2	-	319.6	307.4	247.8	251.3	-
3312	Blast furnaces and steel mills	354.3	340.1	273.6	277.6	-	264.6	253.3	205.1	208.3	-
3317	Steel pipe and tubes	29.8	29.6	21.9	22.2	-	22.3	22.1	15.4	15.6	-
332	Iron and steel foundries	172.0	161.9	137.5	139.1	-	133.2	124.6	103.8	105.7	-
3321	Gray iron foundries	103.8	97.2	88.2	89.7	-	82.7	76.9	69.1	70.8	-
3322	Malleable iron foundries	12.9	12.0	10.6	10.3	-	9.6	8.8	7.7	7.4	-
3325	Steel foundries, nec	43.4	41.1	29.0	29.5	-	33.0	31.1	20.5	21.0	-
333	Primary nonferrous metals	58.9	56.7	48.2	48.6	-	42.8	41.1	34.5	34.8	-
3334	Primary aluminum	30.5	30.0	24.5	24.8	-	22.6	22.4	18.0	18.4	-
335	Nonferrous rolling and drawing	193.1	193.4	181.6	182.3	-	136.9	137.1	127.5	128.5	-
3351	Copper rolling and drawing	27.5	27.0	26.0	26.0	-	20.4	20.0	18.7	18.8	-
3353	Aluminum sheet, plate, and foil	31.0	31.2	29.6	30.0	-	23.6	23.9	23.0	23.3	-
3357	Nonferrous wire drawing and insulating	82.1	82.4	76.3	76.1	-	58.1	58.2	53.6	53.5	-
336	Nonferrous foundries	82.9	82.2	80.6	82.0	-	65.7	64.9	64.0	65.3	-
3361	Aluminum foundries	48.7	48.4	47.8	48.8	-	39.4	39.0	39.0	40.0	-
34	**FABRICATED METAL PRODUCTS**	1,468.8	1,456.9	1,359.7	1,367.3	1,378.5	1,061.7	1,051.5	979.4	987.1	997.6
341	Metal cans and shipping containers	64.9	65.3	62.7	62.6	-	54.7	54.9	53.1	52.9	-
3411	Metal cans	52.7	53.0	50.7	50.6	-	45.2	45.4	43.8	43.6	-
342	Cutlery, hand tools, and hardware	145.5	142.3	136.0	136.7	-	107.4	104.7	99.3	100.2	-
3423,5	Hand and edge tools, and hand saws and blades	51.2	48.4	44.7	44.1	-	38.6	36.2	32.5	32.1	-
3429	Hardware, nec	81.3	80.8	78.9	80.0	-	59.7	59.5	58.4	59.5	-
343	Plumbing and heating, except electric	60.8	60.0	60.1	61.3	-	41.8	41.1	42.2	43.4	-
3432	Plumbing fittings and brass goods	23.4	23.1	23.1	23.3	-	18.4	18.1	18.0	18.0	-
3433	Heating equipment, except electric	28.3	27.4	27.6	28.4	-	17.8	17.0	17.7	18.6	-
344	Fabricated structural metal products	462.6	460.2	417.8	419.3	-	308.0	307.0	277.0	278.8	-
3441	Fabricated structural metal	92.6	91.2	77.5	76.5	-	65.0	63.8	53.1	52.4	-
3442	Metal doors, sash, and trim	70.2	72.1	75.5	77.1	-	49.9	51.6	54.0	55.5	-
3443	Fabricated plate work (boiler shops)	136.2	134.0	112.6	111.1	-	79.8	78.8	65.1	64.3	-
3444	Sheet metal work	102.1	101.3	96.2	97.3	-	73.2	72.5	68.1	68.8	-
3446	Architectural metal work	28.1	27.8	27.3	27.5	-	19.3	18.8	18.7	18.8	-
345	Screw machine products, bolts, etc	94.5	92.9	84.1	85.3	-	71.1	69.5	62.3	63.2	-
3451	Screw machine products	44.0	43.6	39.1	39.9	-	34.7	34.3	30.4	31.0	-
3452	Bolts, nuts, rivets, and washers	50.5	49.2	45.0	45.4	-	36.4	35.2	31.9	32.2	-
346	Metal forgings and stampings	239.1	238.3	225.6	226.3	-	187.8	187.5	177.4	178.1	-
3462	Iron and steel forgings	41.9	40.0	32.4	32.7	-	31.8	30.4	23.8	24.1	-
3465	Automotive stampings	84.2	87.2	85.5	85.8	-	70.7	73.7	72.5	72.5	-
3469	Metal stampings, nec	101.5	99.6	97.0	97.9	-	76.5	74.7	73.2	74.0	-
347	Metal services, nec	97.8	96.9	90.9	92.2	-	77.6	76.7	71.7	73.0	-
3471	Plating and polishing	67.1	66.8	64.5	65.3	-	54.3	54.0	52.1	52.9	-
3479	Metal coating and allied services	30.7	30.1	26.4	26.9	-	23.3	22.7	19.6	20.1	-
348	Ordnance and accessories, nec	64.6	65.0	65.0	65.4	-	41.8	41.7	42.2	42.6	-
3483	Ammunition, exc. for small arms, nec	26.8	27.0	28.2	28.7	-	17.8	17.7	18.7	19.3	-
349	Misc. fabricated metal products	239.0	236.0	217.5	218.2	-	171.5	168.4	154.2	154.9	-
3494	Valves and pipe fittings	98.0	95.9	84.2	84.2	-	65.5	63.5	54.5	54.7	-
3496	Misc. fabricated wire products	50.8	50.5	49.3	49.8	-	38.5	38.0	36.8	37.3	-
35	**MACHINERY, EXCEPT ELECTRICAL**	2,379.8	2,354.9	2,044.3	2,043.7	2,065.8	1,463.0	1,445.2	1,184.1	1,185.0	1,209.1
351	Engines and turbines	119.4	117.6	100.0	98.9	-	73.6	72.7	58.3	57.1	-
3511	Turbines and turbine generator sets	43.3	42.8	39.1	38.6	-	23.1	22.8	21.0	20.6	-
3519	Internal combustion engines, nec	76.1	74.8	60.9	60.3	-	50.5	49.9	37.3	36.5	-
352	Farm and garden machinery	149.4	150.2	130.1	130.2	-	98.1	99.7	83.3	84.2	-
3523	Farm machinery and equipment	129.8	131.4	110.5	112.0	-	83.5	86.0	69.2	71.2	-
353	Construction and related machinery	380.9	372.8	253.6	253.1	-	243.2	237.4	135.1	133.9	-
3531	Construction machinery	121.1	120.5	73.6	74.8	-	74.9	74.8	29.9	29.6	-

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1977 CENSUS OF MANUFACTURES

Industry Series

Industrial Organic Chemicals

2861	Gum and Wood Chemicals
2865	Cyclic Crudes and Intermediates
2869	Industrial Organic Chemicals, N.E.C.

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Director

USERS' GUIDE IN LOCATING STATISTICS BY TABLE NUMBER

(For explanation of terms, see appendix A)

	Item	4-digit industry statistics		
		Historical	Operating ratios	By geographic area
1	Number of manufacturing establishments	1a		2
	Employment and payroll:			
2	Number of employees	1a	1b	2
3	Payroll	1a	1b	2
4	Supplemental labor costs			
5	Production workers	1a	1b	2
6	Production worker hours	1a	1b	2
7	Production worker wages	1a	1b	2
	Shipments, cost of materials, and value added:			
8	Value of shipments (4-digit)	1a	1b	2
9	Product class shipments (5-digit)			
10	Product shipments (7-digit)			
11	Value added by manufacture	1a	1b	2
12	Cost of materials	1a	1b	2
13	Cost of fuels and electric energy			
14	Materials consumed by kind			
	Inventories:			
15	End of year	1a		
16	Stage of fabrication			
	Capital expenditures, assets, rental payments, and purchased services:			
17	New capital expenditures	1a		2
18	Used plant and equipment expenditures			
19	Gross assets	1a	1b	
20	Depreciation			
21	Retirements of buildings and machinery			
22	Rental payments			
23	Purchased services			
	Ratios:			
24	Specialization	1a		
25	Coverage	1a		

[1] Detailed information shown

4 digit industry statistics Con.				5 digit product class and 7-digit product statistics				
Summary and supplemental	By employment size	By industry and product class specialization	Materials consumed by kind	Industry product analysis	Product shipments	Product class by geographic area	Historical product class	
[1]3a	4	5a						1
3a	4	5a						2
3a	4	5a						3
[1]3b								4
[1]3a	4	5a						5
[1]3a	4	5a						6
3a	4	5a						7
3a	4	5a		5b, 5c				8
				5b, 5c	6a	6b	6c	9
					6a			10
3a	4	5a						11
[1]3a	4	5a						12
3a								13
			7a					14
3a	4							15
3a								16
[1]3a, [1]3b	4	5a						17
[1]3a [1]3b								18
[1]3b								19
[1]3b								20
[1]3b								21
[1]3b								22
[1]3b								23
3a				5b				24
3a				5b				25

Table 1a. **Historical Statistics for the Industry: 1977 and Earlier Years**

Year[1]	Companies[2] (no.)	All establishments		All employees		Production workers			Value added by manufacture (million dollars)	Cost of materials (million dollars)	Value of shipments (million dollars)	Expenditures and assets		End-of-year inventories (million dollars)	Ratios	
		Total (no.)	With 20 employees or more (no.)	Number (1,000)	Payroll (million dollars)	Number (1,000)	Hours (millions)	Wages (million dollars)				New capital expenditures (million dollars)	Gross value of fixed assets (million dollars)		Specialization (percent)	Coverage (percent)
	INDUSTRY 2861, GUM AND WOOD CHEMICALS															
1977 Census	100	119	37	4.8	54.0	3.8	7.8	38.9	185.0	205.3	391.3	27.0	(NA)	85.7	78	87
1976 ASM[6]	(NA)	(NA)	(NA)	4.7	47.2	3.7	7.4	35.0	147.2	210.8	384.8	32.0	184.8	71.2	(NA)	(NA)
1975 ASM	(NA)	(NA)	(NA)	4.6	42.6	3.7	6.7	31.9	130.2	196.4	314.2	12.6	182.1	78.4	(NA)	(NA)
1974 ASM	(NA)	(NA)	(NA)	5.1	44.5	4.2	7.8	34.0	199.5	220.8	403.3	10.0	148.8	84.8	(NA)	(NA)
1973 ASM	(NA)	(NA)	(NA)	5.5	46.6	4.1	8.6	33.5	181.1	178.8	355.4	15.2	210.8	57.4	(NA)	(NA)
1972 Census	118	139	41	5.9	47.6	4.7	9.4	33.5	155.4	175.9	332.3	11.1	203.1	52.2	70	75
1971 ASM	(NA)	(NA)	(NA)	5.2	40.8	4.1	8.2	28.5	143.0	144.7	279.4	10.5	187.9	49.7	(NA)	(NA)
1970 ASM	(NA)	(NA)	(NA)	5.3	37.9	4.2	8.4	28.8	118.3	144.0	281.7	8.9	185.3	39.3	(NA)	(NA)
1969 ASM	(NA)	(NA)	(NA)	5.8	36.0	4.7	9.3	25.6	102.3	130.0	228.5	9.3	152.8	47.6	(NA)	(NA)
1968 ASM	(NA)	(NA)	(NA)	5.7	35.0	4.4	8.7	24.2	117.2	114.8	233.3	13.7	147.8	45.8	(NA)	(NA)
1967 Census	172	184	42	5.9	33.5	4.6	9.0	23.1	100.8	115.3	215.9	20.6	139.2	48.3	73	76
1966 ASM[6]	(NA)	(NA)	(NA)	5.0	31.5	3.8	7.9	21.4	99.2	109.8	208.7	6.6	(NA)	43.5	(NA)	(NA)
1965 ASM	(NA)	(NA)	(NA)	5.8	32.1	4.3	8.8	21.9	92.6	112.3	206.2	4.4	(NA)	46.4	(NA)	(NA)
1964 ASM	(NA)	(NA)	(NA)	6.4	32.4	5.0	10.1	22.4	102.3	116.9	222.0	4.9	116.1	46.9	(NA)	(NA)
1963 Census	229	246	53	6.8	32.7	5.4	10.8	22.9	100.3	114.8	212.9	5.8	115.2	53.7	74	77
	INDUSTRY 2865, CYCLIC CRUDES AND INTERMEDIATES															
1977 Census	135	191	127	35.7	631.5	23.4	46.6	369.8	2 214.4	3 453.8	5 637.0	443.1	(NA)	844.4	68	67
1976 ASM	(NA)	(NA)	(NA)	27.8	441.8	17.9	35.8	282.6	1 798.7	2 956.6	4 677.7	443.6	3 345.4	706.8	(NA)	(NA)
1975 ASM	(NA)	(NA)	(NA)	27.8	406.1	17.9	36.4	242.4	1 353.8	2 442.6	3 619.2	432.0	3 111.4	613.9	(NA)	(NA)
1974 ASM	(NA)	(NA)	(NA)	27.6	385.0	18.4	38.3	222.6	1 465.3	2 078.3	3 413.3	319.9	2 504.3	825.0	(NA)	(NA)
1973 ASM	(NA)	(NA)	(NA)	29.5	348.0	19.0	39.4	207.1	1 140.3	1 286.0	2 428.4	200.6	2 356.3	376.1	(NA)	(NA)
1972 Census	123	174	118	28.2	318.2	18.7	38.4	191.1	929.7	1 110.3	2 049.6	158.8	2 174.8	356.0	76	65
1971 ASM	(NA)	(NA)	(NA)	30.0	315.9	20.0	41.7	195.3	965.4	1 037.4	1 967.8	279.6	2 237.9	371.7	(NA)	(NA)
1970 ASM	(NA)	(NA)	(NA)	30.2	293.6	19.9	41.3	178.7	855.1	960.3	1 804.0	283.2	2 010.8	317.7	(NA)	(NA)
1969 ASM	(NA)	(NA)	(NA)	30.9	289.8	20.8	43.8	179.2	840.7	975.3	1 799.9	140.4	1 805.4	304.1	(NA)	(NA)
1968 ASM	(NA)	(NA)	(NA)	30.2	285.1	20.5	42.2	184.1	774.8	938.8	1 718.1	99.3	1 696.2	277.0	(NA)	(NA)
1967 Census	115	177	107	30.0	251.1	20.3	41.7	152.9	720.5	874.5	1 598.8	138.1	1 612.8	281.6	73	66
1966 ASM	(NA)	(NA)	(NA)	29.2	240.4	20.1	42.6	150.1	741.7	826.3	1 556.3	88.4	(NA)	247.3	(NA)	(NA)
1965 ASM	(NA)	(NA)	(NA)	29.6	232.3	19.9	41.6	141.9	682.3	768.5	1 458.3	91.9	(NA)	232.5	(NA)	(NA)
1964 ASM	(NA)	(NA)	(NA)	28.2	211.3	18.7	38.5	128.5	821.1	868.3	1 289.6	103.5	1 118.4	209.0	(NA)	(NA)
1963 Census	120	141	84	27.7	201.9	18.9	38.6	124.8	805.3	834.1	1 212.8	106.8	1 047.8	211.0	(NA)	(NA)
	INDUSTRY 2869, INDUSTRIAL ORGANIC CHEMICALS, N.E.C.															
1977 Census	388	569	346	112.3	2 108.7	70.7	145.7	1 216.5	10 475.7	13 948.8	24 232.8	3 162.8	(NA)	2 942.7	89	84
1976 ASM	(NA)	(NA)	(NA)	109.3	1 859.2	68.7	139.0	1 059.0	9 402.6	11 548.5	20 642.8	2 206.8	15 442.9	2 518.2	(NA)	(NA)
1975 ASM	(NA)	(NA)	(NA)	104.9	1 630.3	64.8	129.7	904.2	8 027.4	9 126.7	16 923.3	1 675.2	13 088.8	2 222.6	(NA)	(NA)
1974 ASM	(NA)	(NA)	(NA)	102.5	1 469.6	65.6	134.8	847.3	7 659.9	8 309.7	15 536.9	1 259.5	11 415.2	1 944.7	(NA)	(NA)
1973 ASM	(NA)	(NA)	(NA)	102.8	1 332.4	66.1	135.5	778.1	5 582.3	5 045.6	10 665.9	789.6	10 692.0	1 148.0	(NA)	(NA)
1972 Census	349	514	295	102.4	1 248.6	64.5	129.9	713.0	4 988.0	4 228.2	9 223.5	661.7	10 113.0	1 078.1	r72	65
1971 ASM	(NA)	(NA)	(NA)	100.2	1 140.7	63.8	129.1	649.5	4 530.8	3 658.0	8 214.3	859.4	9 409.7	1 044.2	(NA)	(NA)
1970 ASM	(NA)	(NA)	(NA)	104.2	1 099.7	66.4	135.9	629.1	4 225.4	3 607.0	7 739.7	736.1	9 007.9	1 053.3	(NA)	(NA)
1969 ASM	(NA)	(NA)	(NA)	101.6	1 023.0	65.7	137.4	597.4	3 978.6	3 374.6	7 253.2	711.7	8 263.0	938.7	(NA)	(NA)
1968 ASM	(NA)	(NA)	(NA)	98.6	925.4	63.6	131.8	545.4	3 818.8	3 154.8	8 965.8	884.8	7 716.0	817.1	(NA)	(NA)
1967 Census	339	488	268	95.1	844.9	62.4	126.4	499.8	3 575.3	2 849.0	8 377.8	781.2	6 882.3	801.1	72	81
1966 ASM	(NA)	(NA)	(NA)	95.7	833.4	63.6	129.0	491.6	3 641.5	2 953.1	8 541.1	868.2	(NA)	770.1	(NA)	(NA)
1965 ASM	(NA)	(NA)	(NA)	91.6	788.0	61.3	125.2	482.5	3 471.7	2 815.7	8 012.5	841.2	(NA)	687.8	(NA)	(NA)
1964 ASM	(NA)	(NA)	(NA)	87.1	714.0	57.0	117.8	428.6	2 990.9	2 297.1	5 285.3	496.4	(NA)	587.0	(NA)	(NA)
1963 Census	343	464	241	85.5	677.3	56.4	114.4	405.0	2 727.5	2 105.7	4 840.2	401.0	(NA)	552.8	72	81

– Represents zero. (D) Withheld to avoid disclosing operations of individual companies. (NA) Not available. n.e.c. Not elsewhere classified. r Revised. (S) Withheld because estimate did not meet publication standards. (X) Not applicable. (Z) Less than 50 thousand dollars or hours, under 50 employees.

[1] In annual survey of manufactures (ASM) years, data are estimates based on a representative sample of establishments canvassed annually and may differ from results of a complete canvass of all establishments. ASM publication shows percentage standard errors. Unless otherwise noted, for data prior to 1963, see 1963 Census of Manufactures, vol. II, table 1 of the industry chapter.

[2] For the census, a company is defined as a business organization consisting of one establishment or more under common ownership or control.

[3] Industry was defined or redefined for 1972 Census of Manufactures, so data are available only for years shown.

[4] Data for 1967 and 1963 were derived from Table 8, General Statistics for Establishments by Industry Specialization and Primary Product Class Specialization, in vol. II of the 1967 and 1963 Censuses of Manufactures. Separate data for other years are not available.

[5] Data either have associated standard errors exceeding 15 percent or are not consistent with other census series and related data, thus these estimates may be of limited reliability.

[6] Estimate for new capital expenditures has associated standard error of 15 percent or more and may be of limited reliability. Estimates for other data items are of acceptable reliability.

[7] Minimum percentage, exact percentage withheld to avoid disclosing operations of individual companies.

[8] Relationships are not meaningful because of predominance of miscellaneous receipts, particularly receipts for contract and commission work on materials owned by others.

[9] Data in value of shipments column represent value of production rather than value of shipments. Consequently, formula for computing value added by manufacture was modified to exclude any change in finished products inventories between beginning and end of year.

[10] Data in value of shipments column represent value of work done rather than value of shipments. Consequently, formula for computing value added by manufacture was modified to exclude any change in inventories between beginning and end of year.

Table 2. Industry Statistics by Geographic Area: 1977 and 1972

Geographic area	1977												1972	
		All establishments		All employees		Production workers								
	E[1]	Total (no.)	With 20 employees or more (no.)	Number[2] (1,000)	Payroll (million dollars)	Number (1,000)	Hours (millions)	Wages (million dollars)	Value added by manufacture (million dollars)	Cost of materials (million dollars)	Value of shipments (million dollars)	New capital expenditures (million dollars)	All employees[2] (1,000)	Value added by manufacture (million dollars)
INDUSTRY 2861, GUM AND WOOD CHEMICALS														
United States	-	119	37	4.8	54.0	3.6	7.6	38.9	185.0	205.3	391.3	27.0	5.9	155.4
West North Central Division														
Missouri	E1	24	5	CC	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	CC	(D)
North Dakota		1	1	AA	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(NA)	(NA)
South Atlantic Division														
West Virginia		1	1	AA	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	AA	(D)
Georgia		8	2	FF	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	EE	(D)
Florida		9	5	CC	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	EE	(D)
East South Central Division														
Kentucky	-	1	1	AA	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	AA	(D)
West South Central Division														
Arkansas	-	7	2	AA	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(NA)	(NA)
Texas	E3	16	2	0.2	1.8	0.1	0.3	1.4	4.7	4.4	9.0	0.7	(NA)	(NA)
Pacific Division														
Oregon	-	3	2	BB	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	AA	(D)
INDUSTRY 2865, CYCLIC CRUDES AND INTERMEDIATES														
United States	-	191	127	35.7	831.6	23.4	46.6	369.6	2 214.4	3 453.6	5 637.0	443.1	28.2	929.7
New England Division														
Massachusetts	E1	6	2	BB	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	BB	(D)
Rhode Island	-	2	1	CC	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	CC	(D)
Connecticut	-	2	1	BB	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	AA	(D)
Middle Atlantic Division														
New York	-	12	6	2.8	44.6	1.9	3.5	28.4	142.5	100.0	242.3	(D)	2.6	49.1
New Jersey	-	42	30	12.3	237.7	8.6	16.7	141.8	605.6	805.5	1 402.9	(D)	8.3	234.0
Pennsylvania	-	14	9	1.6	23.8	1.0	2.2	14.1	110.8	178.2	288.6	(D)	1.8	50.3
East North Central Division														
Ohio	-	13	10	FF	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	EE	(D)
Illinois		16	10	2.6	46.9	1.7	3.4	29.1	156.4	260.3	423.7	40.4	2.6	78.5
Michigan		4	3	0.7	7.9	0.4	0.8	5.8	21.0	38.6	58.9	2.0	CC	(D)
South Atlantic Division														
Delaware		2	2	CC	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	CC	(D)
Maryland	-	3	2	CC	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	CC	(D)
West Virginia	-	7	5	FF	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	EE	(D)
North Carolina	-	7	5	EE	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	CC	(D)
South Carolina	-	8	7	CC	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	CC	(D)
East South Central Division														
Kentucky	-	1	1	BB	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(NA)	(NA)
Tennessee	-	2	2	AA	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	CC	(D)
Alabama	-	4	4	EE	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	CC	(D)
West South Central Division														
Louisiana	-	3	3	BB	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	AA	(D)
Texas	-	13	10	2.7	57.6	1.6	3.4	27.5	440.5	716.9	1 143.4	58.2	EE	(D)
Pacific Division														
California	-	8	5	BB	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	AA	(D)
INDUSTRY 2869, INDUSTRIAL ORGANIC CHEMICALS, N.E.C.														
United States	-	569	348	112.3	2 108.7	70.7	145.7	1 216.5	10 475.7	13 948.6	24 232.8	3 162.6	102.4	4 988.0
New England Division														
New Hampshire	-	2	2	BB	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	AA	(D)
Massachusetts	-	10	5	1.2	21.5	0.7	1.5	12.4	48.4	75.9	122.4	3.3	AA	(D)
Rhode Island	-	4	3	CC	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	CC	(D)
Connecticut	-	13	8	EE	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	FF	(D)
Middle Atlantic Division														
New York	-	39	23	4.2	72.4	2.4	5.1	33.0	225.1	226.2	445.8	(D)	6.1	158.8
New Jersey	-	73	45	7.7	138.1	5.1	10.8	83.6	512.3	810.8	1 320.7	59.8	13.1	448.2
Pennsylvania	-	23	13	4.3	72.2	2.7	5.3	41.2	171.2	370.2	552.0	22.3	2.0	32.9
East North Central Division														
Ohio	-	31	17	2.9	52.0	1.6	3.6	30.6	275.9	376.2	634.2	50.4	3.1	99.6
Indiana	-	6	3	CC	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	EE	(D)
Illinois	-	28	11	2.0	32.2	1.3	2.3	19.7	177.1	184.1	354.8	30.4	EE	(D)
Michigan	-	20	13	7.6	141.8	4.7	9.0	79.5	401.9	348.9	736.7	91.7	FF	(D)
Wisconsin	-	11	6	CC	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	BB	(D)
West North Central Division														
Iowa		3	2	CC	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	AA	(D)
Missouri		11	2	FF	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	EE	(D)
Kansas		6	2	AA	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(NA)	(NA)

See footnotes at end of table.

Table 3a Summary Statistics for the Industry: 1977

Item	Unit of measure	Gum and wood chemicals (SIC 2861)	Cyclic crudes and intermediates (SIC 2865)	Industrial organic chemicals, n e c (SIC 2869)
Primary product specialization ratio[1]	percent	76	68	69
Coverage ratio[2]	do	67	67	84
All establishments	number	119	191	569
With 1 to 19 employees	do	82	64	223
With 20 to 99 employees	do	24	58	164
With 100 employees or more	do	13	69	182
All employees, average for year	1,000	4.8	35.7	112.3
Payroll for year, all employees	mil dol	54.0	631.5	2 108.7
Production workers				
Average for year	1,000	3.8	23.4	70.7
March	do	3.6	23.5	69.7
May	do	3.9	23.7	70.2
August	do	3.9	23.3	71.5
November	do	3.7	23.1	71.1
Hours	millions	7.8	46.6	145.7
January to March	do	1.8	11.9	35.9
April to June	do	2.0	11.9	36.5
July to September	do	2.0	11.4	36.7
October to December	do	1.9	11.4	36.6
Wages	mil dol	38.9	369.8	1 216.5
Cost of materials, etc	do	205.3	3 453.6	13 948.8
Materials, parts containers etc consumed	do	179.6	2 925.0	11 405.5
Resales	do	1.6	113.6	420.5
Fuels consumed	do	18.9	271.8	1 393.9
Purchased electric energy	do	4.7	113.1	452.8
Contract work	do	0.5	30.1	276.0
Value of shipments, including resales	do	391.3	5 637.0	24 232.8
Value of resales	do	3.7	127.2	496.1
Value added by manufacture	do	185.0	2 214.4	10 475.7
Manufacturers inventories				
Beginning of year	do	63.6	784.2	2 591.5
Finished products	do	40.6	350.9	1 247.3
Work in process	do	2.3	165.7	474.7
Materials, supplies, fuel, etc	do	20.7	267.7	869.4
End of year	do	65.7	844.4	2 942.7
Finished products	do	40.4	391.7	1 419.7
Work in process	do	1.6	155.8	494.1
Materials, supplies, fuel, etc	do	23.8	296.9	1 028.9
Capital expenditures for plant and equipment	do	34.7	448.6	3 189.5
New capital expenditures	do	27.0	443.1	3 162.6
New buildings and other structures	do	10.8	52.6	447.7
New machinery and equipment	do	16.2	390.5	2 714.9
Used capital expenditures	do	7.7	5.5	26.9

Represents zero (D) Withheld to avoid disclosing operations of individual companies (NA) Not available n e c Not elsewhere classified (S) Withheld because estimate did not meet publication standards (X) Not applicable (Z) Less than 50 thousand dollars or hours, under 50 employees

[1] Represents ratio of primary product shipments to total product shipments (primary and secondary, excluding miscellaneous receipts) for establishments classified in industry

[2] Represents ratio of primary products shipped by establishments classified in industry to total shipments of such products by all manufacturing establishments, wherever classified

[3] Relationships are not meaningful because of predominance of miscellaneous receipts, particularly receipts for contract and commission work on materials owned by others

[4] Minimum percentage, exact percentage withheld to avoid disclosing operations of individual companies

[5] Data for value of shipments represent value of production rather than value of shipments Consequently, formula for computing value added by manufacture was modified to exclude any change in finished products inventories between beginning and end of year

[6] Data for value of shipments represent value of work done rather than value of shipments Consequently, formula for computing value added by manufacture was modified to exclude any change in inventories between beginning and end of year

[7] Four digit industry totals for all items including establishment counts are not equal to sum of 6-digit subindustry figures due to difficulties in classifying a few establishments at subindustry level

Table 4. **Industry Statistics by Employment Size of Establishment: 1977**

Industry and employment size class	E[1]	All establishments (no.)	All employees		Production workers			Value added by manufacture (million dollars)	Cost of materials (million dollars)	Value of shipments (million dollars)	New capital expenditures (million dollars)	End-of-year inventories (million dollars)
			Number (1,000)	Payroll (million dollars)	Number (1,000)	Hours (millions)	Wages (million dollars)					
INDUSTRY 2861, GUM AND WOOD CHEMICALS												
Total	-	**119**	**4.8**	**54.0**	**3.8**	**7.8**	**38.9**	**185.0**	**205.3**	**391.3**	**27.0**	**65.7**
Establishments with an average of—												
1 to 4 employees	E8	49	0.1	1.0	0.1	0.2	0.7	3.2	4.2	7.4	(7.8)	1.3
5 to 9 employees	E4	15	0.1	1.0	0.1	0.2	0.8	4.1	6.3	10.4	(D)	1.3
10 to 19 employees	E3	18	0.3	2.5	0.2	0.4	1.8	6.3	12.3	19.0	0.8	3.4
20 to 49 employees		14	0.5	4.7	0.4	0.8	3.5	17.0	16.7	33.3	1.1	8.2
50 to 99 employees		10	0.7	6.2	0.5	1.2	4.8	26.6	29.9	55.8	(17.5)	10.7
100 to 249 employees		10	(3.2)	(30.5)	(2.5)	(5.0)	(27.3)	(127.8)	(135.9)	(265.4)	(D)	(40.8)
250 to 499 employees		2	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
500 to 999 employees		1	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
Covered by administrative records[2]	E0	54	0.2	2.0	0.2	0.3	1.5	6.0	7.6	13.8	1.1	2.5
INDUSTRY 2865, CYCLIC CRUDES AND INTERMEDIATES												
Total	-	**191**	**35.7**	**631.5**	**23.4**	**48.6**	**389.8**	**2 214.4**	**3 453.8**	**5 837.0**	**443.1**	**844.4**
Establishments with an average of—												
1 to 4 employees	E9	22	(Z)	0.5	(Z)	(Z)	0.3	0.7	3.3	5.0	0.5	0.7
5 to 9 employees	E4	17	0.1	2.0	0.1	0.2	1.1	1.2	20.3	21.5	1.0	2.4
10 to 19 employees	E4	25	0.3	5.0	0.2	0.4	2.7	18.4	33.4	51.3	6.0	8.5
20 to 49 employees	-	34	1.1	18.4	0.7	1.5	10.0	81.8	159.2	242.2	7.4	28.2
50 to 99 employees	-	24	1.7	27.5	1.1	2.3	14.9	96.8	213.5	304.2	23.0	41.5
100 to 249 employees	-	29	4.1	66.0	2.6	5.3	38.9	240.6	395.3	828.8	55.1	109.2
250 to 499 employees	-	23	7.9	131.4	4.7	9.8	75.4	482.0	940.1	1 390.4	80.8	237.8
500 to 999 employees	-	11	7.6	137.6	5.0	9.7	77.2	850.4	979.2	1 832.5	112.1	174.7
1 000 to 2 499 employees	-	6	(12.8)	(245.2)	(9.0)	(17.5)	(151.4)	(662.5)	(709.3)	(1 381.3)	(157.4)	(241.5)
Covered by administrative records[2]	E0	35	0.2	3.7	0.2	0.3	2.2	10.5	19.4	29.8	2.7	4.5
INDUSTRY 2869, INDUSTRIAL ORGANIC CHEMICALS, N.E.C.												
Total	-	**569**	**112.3**	**2 108.7**	**70.7**	**145.7**	**1 216.5**	**10 475.7**	**13 946.8**	**24 232.8**	**3 182.6**	**2 942.7**
Establishments with an average of—												
1 to 4 employees	E4	117	0.2	2.9	0.1	0.3	1.7	13.6	21.7	35.7	2.8	4.5
5 to 9 employees	E4	56	0.4	6.4	0.3	0.5	3.7	25.9	38.6	64.0	4.5	8.3
10 to 19 employees	E2	50	0.7	11.4	0.4	0.9	5.8	46.0	68.9	118.8	8.9	14.5
20 to 49 employees	-	83	2.7	42.3	1.6	3.4	21.8	180.6	259.8	440.8	68.3	47.1
50 to 99 employees	-	81	5.9	97.4	3.4	8.0	50.8	498.4	752.7	1 241.3	98.9	178.1
100 to 249 employees		80	13.2	223.5	8.2	17.2	128.7	1 023.3	1 540.1	2 539.2	188.6	352.7
250 to 499 employees	-	46	18.8	308.1	10.8	22.8	180.5	1 852.5	2 730.9	4 358.7	732.4	487.1
500 to 999 employees		30	20.2	390.1	13.3	27.2	238.8	1 874.5	2 339.7	4 178.7	285.8	433.5
1 000 to 2 499 employees		22	(52.3)	(1 026.5)	(32.6)	(66.7)	(569.3)	(5 160.6)	(8 198.8)	(11 256.1)	(1 794.4)	(1 438.9)
2,500 employees or more	-	4	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
Covered by administrative records[2]	E0	130	0.5	8.8	0.3	0.8	5.0	29.1	37.3	68.4	7.2	6.2

Represents zero (D) Withheld to avoid disclosing operations of individual companies. Data for this item are included in figures in parentheses above (NA) Not available n.e.c. Not elsewhere classified (S) Withheld because estimate did not meet publication standards (X) Not applicable (Z) Less than 50 thousand dollars or hours, under 50 employees

[1] Payroll and sales data for small single-unit companies with up to 20 employees (cutoff varied by industry) were obtained from administrative records of other government agencies rather than from census report forms. These data were then used in conjunction with industry averages to estimate the balance of items shown for these small establishments. This technique was also used for a small number of other establishments whose reports were not received at time data were tabulated. The following symbols are shown where estimated data based on administrative records data account for 10 percent or more of figures shown: E1—10 to 19 percent, E2—20 to 29 percent, E3—30 to 39 percent; E4—40 to 49 percent; E5—50 to 59 percent; E6—60 to 69 percent, E7—70 to 79 percent, E8—80 to 89 percent, E9—90 to 99 percent, E0—100 percent

[2] Report forms were not mailed to small single-unit companies with up to 20 employees (cutoff varied by industry). Payroll and sales data for 1977 were obtained from administrative records supplied by other agencies of the Federal Government. These data were then used in conjunction with industry averages to estimate the balance of items shown. Data are also included in respective size classes shown

[3] Data in value of shipments column represent value of production rather than value of shipments. Consequently, formula for computing value added by manufacture was modified to exclude any change in finished products inventories between beginning and end of year

[4] Data in value of shipments column represent value of work done rather than value of shipments. Consequently, formula for computing value added by manufacture was modified to exclude any change in inventories between beginning and end of year

[5] Four digit industry totals for all items including establishment counts are not equal to sum of 6-digit subindustry figures due to difficulties in classifying a few establishments at subindustry level

Table 5a Industry Statistics by Industry and Primary Product Class Specialization: 1977

[Table presents selected statistics for establishments according to their degree of specialization in products primary to their industry Measures of plant specialization shown are (1) industry specialization ratio of primary product shipments to total product shipments (primary plus secondary, excluding miscellaneous receipts) for the establishment, and (2) product class specialization ratio of largest primary product class shipments to total product shipments (primary plus secondary, excluding miscellaneous receipts) for the establishment See appendix for method of computing ratios Statistics for establishments with specialization ratios of less than 75 percent are included in total lines but are not shown as a separate class. In addition, data may not be shown for various reasons, e g , to avoid disclosing operations of individual companies For explanation of terms, see appendix A]

Industry or product class code	Industry or product class by percent of specialization	All establishments (number)	All employees: Number (1,000)	All employees: Payroll (million dollars)	Production workers: Number (1,000)	Production workers: Hours (millions)	Production workers: Wages (million dollars)	Value added by manufacture (million dollars)	Cost of materials (million dollars)	Value of shipments (million dollars)	New capital expenditures (million dollars)
2861	**Gum and wood chemicals**										
	Entire industry	119	4 8	54 0	3 8	7 8	38 8	185 0	205 3	381 3	27 0
	Establishments with 75 percent specialization or more	106	2 9	26 1	2 4	4 9	20 2	87 7	98 9	186 0	9 4
28611	Softwood distillation products										
	Establishments with this product class primary	9	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
	Establishments with 75 percent specialization or more in class	7	0 3	3 7	0 2	0.5	2.9	9.1	9 5	18 3	1 0
28612	Other gum and wood chemicals										
	Establishments with this product class primary	46	2 9	27.9	2 3	4 7	20.7	104.4	125.4	229 9	8 7
	Establishments with 75 percent specialization or more in class	36	2 3	19 0	1 9	3 9	14 9	66 4	75.4	141 6	(D)
2865	**Cyclic crudes and intermediates:**										
	Entire industry	191	35 7	631 5	23 4	46 6	369 8	2 214 4	3 453 6	5 637.0	443 1
	Establishments with 75 percent specialization or more	145	15 4	245 3	9 7	19 4	140 4	822 2	1 678 0	2 495 2	175 1
28651	Cyclic intermediates.										
	Establishments with this product class primary	58	20 5	400 2	13 4	26 9	227 9	1 549 1	2 523 0	4 059 4	342.3
	Establishments with 75 percent specialization or more in class	28	4 6	87 4	2 6	5 6	45 1	390.3	971.9	1 376 4	113 9
28652	Synthetic organic dyes										
	Establishments with this product class primary	32	8 7	129 2	5 8	11 5	80 8	394 9	414 2	795.9	64 4
	Establishments with 75 percent specialization or more in class	24	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
28653	Synthetic organic pigments, lakes, and toners										
	Establishments with this product class primary	31	4 8	72 3	3 0	5 7	42 0	177 9	255 3	428 2	20 0
	Establishments with 75 percent specialization or more in class	21	2 3	30 2	1 4	2.8	19 3	83 0	109 4	188.0	9 8
28655	Cyclic (coal tar) crudes										
	Establishments with this product class primary	19	1.3	23.0	0 9	2.0	15 1	72 3	223 1	296 5	12 0
	Establishments with 75 percent specialization or more in class	14	0 6	9 7	0 4	0 9	6 9	48 0	99 3	147 2	7 4
2869	**Industrial organic chemicals, n.e.c..**										
	Entire industry	569	112 3	2 108 7	70 7	145 7	1 216 5	10 475 7	13 948 8	24 232 8	3 182 8
	Establishments with 75 percent specialization or more	434	48 2	861 6	31 0	62 4	509 7	4 247 0	6 406 4	10 802.4	1 435 8
28693	Synthetic organic chemicals, n e c										
	Establishments with this product class primary	65	9 2	159.0	5 7	11.9	86 9	583 8	878 7	1 445.5	65 9
	Establishments with 75 percent specialization or more in class	40	3 1	50.9	2 1	4 2	28.2	213 1	308 8	518.6	17.9
28694	Pesticides and other organic agricultural chemicals										
	Establishments with this product class primary	21	7 7	141 4	5 4	10 8	91 2	947 7	709 0	1 866 1	132 4
	Establishments with 75 percent specialization or more in class	10	1 8	32 1	1 3	2 5	20 0	401 1	282 0	689 1	34 7
28695	Ethyl alcohol and other industrial organic chemicals, n.e.c.										
	Establishments with this product class primary	62	5 4	80 9	3 1	6 0	40 9	311 3	358 4	659 7	87 8
	Establishments with 75 percent specialization or more in class	45	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
28696	Miscellaneous end use chemicals and chemical products, except urea										
	Establishments with this product class primary	45	17 9	316 2	11 3	23 4	182 9	1 020 2	1 607.3	2 606 5	169 6
	Establishmants with 75 percent specialization or more in class	20	3 6	61 8	2 4	4 7	38 9	265.2	440.2	708 1	35.1
28697	Miscellaneous cyclic and acyclic chemicals and chemical products										
	Establishments with this product class primary	180	70 4	1 381 2	44 1	91 5	798 8	7 526 2	10 273.5	17 647.1	2 688 2
	Establishments with 75 percent specialization or more in class	99	17 0	320 8	10 9	22 4	194 1	1 706 8	3 344 2	5 029 2	479 1

Represents zero (D) Withheld to avoid disclosing operations of individual companies (NA) Not available n e c Not elsewhere classified (S) Withheld because estimate did not meet publication standards (X) Not applicable (Z) Less than 50 thousand dollars or hours, under 50 employees

[1] Data in value of shipments column represent value of production rather than value of shipments Consequently, formula for computing value added by manufacture was modified to exclude any change in finished products inventories between beginning and end of year

[2] Data in value of shipments column represent value of work done rather than value of shipments Consequently, formula for computing value added by manufacture was modified to exclude any change in inventories between beginning and end of year

Procedures Used to Develop the 1978, 1979, 1980, and Projected 1990 OES Survey-Based Matrices

Introduction

The Bureau of Labor Statistics converted the National industry-occupational matrix from a Census base to an Occupational Employment Statistics (OES) survey base in 1981. This paper presents a brief overview of the general procedures established to develop OES survey-based matrices and describes the detailed steps used to develop the first National matrices based on OES survey data.

In early 1982, a bulletin will be published presenting the 1978 and 1990 matrices. The 1980 and 1990 matrices are the basis of the analytical statements on employment outlook and job openings for the 1982-83 edition of the Occupational Outlook Handbook.

OVERVIEW

Because the OES surveys are conducted on a three-year cycle in which each covered industry is only surveyed once in each cycle, a matrix developed for any given reference year must be based on survey data for three different years. Given this data constraint, a matrix for any given year should most accurately describe occupational employment by industry if it were based on data that were at most one year from the reference year. For example, OES survey data for 1978, 1979, and 1980 should provide the most reliable data to construct a 1979 matrix based on OES survey data.

The timing in which National OES survey data become available and the established cycle for production of National occupational projections and publication of the Occupational Outlook Handbook, however, have resulted in the development of procedures in which matrices are developed for specific reference years prior to the availability of the most reliable data that will become available. Survey data are generally not available until late December of the year following the survey reference year. For example, 1980 OES survey data will not be available until December 1981. Program commitments, however, required that data for 1980 be presented in the Occupational Outlook Handbook that was completed in mid-1981 and which will be published in 1982. Because staffing patterns do not change significantly over a three-year period, procedures were developed in which a preliminary 1980 matrix was developed using the survey data available at the time the employment estimates presented in the Handbook were developed.

The following is a general description of the system that has been designed for developing OES survey-based matrices. Three base year or current matrices will be produced for every reference year. They are to be titled I, Preliminary; II, Revised; and III, Final. The preliminary matrix will be based on OES survey data for the three years prior to the reference year. The revised matrix will be based on OES survey data for the reference year and the two previous years. The final matrix will be based on OES survey data for the reference year, the previous year, and the year following the reference year. The 1979-I matrix, therefore, is based on OES survey data for 1976, 1977, and 1978. The 1979-II matrix uses 1977, 1978, and 1979 survey data. A 1979-III matrix will be constructed using 1978, 1979, and 1980 data after the latter become available in December 1981.

To develop employment data for each reference year's matrix (whether it is a I, II, or III), the staffing patterns from the OES survey data are applied to actual annual average industry employment totals from the Current Employment Survey--CES--(ES-202 data for industries for which CES data are not available) for the reference year. To develop a matrix that covers all workers, the OES survey-based data are supplemented with data for industries not covered by the OES surveys. Estimates of occupational employment of self-employed persons and unpaid family workers are also developed and added at the total all industries level.

DETAILED DESCRIPTION OF PROCEDURES USED TO DEVELOP THE FIRST CURRENT AND PROJECTED NATIONAL OES SURVEY-BASED MATRICES

The first National OES survey-based matrices were developed during 1980 and 1981. Matrices were developed for the years 1978, 1979, 1980, and projected 1990. Current or base year matrices produced include a 1978-II, 1978-III, 1979-I, 1979-II, and a 1980-I. For industries covered by the OES surveys, the 1978-II and 1979-I have the same staffing patterns and the 1978-III, 1979-II, and 1980-I have the same staffing patterns. Staffing patterns for the nonsurveyed sectors and the occupational distribution of self-employed persons and unpaid family workers are the same for the three matrices for each reference year, whether a I, II, or III matrix, because the actual source data for the reference year were available at the time the matrix was developed.

Current Year Matrices (1978, 1979, and 1980)

Industry Controls

In all current years, industry controls for wage and salary workers in the 378 industries in the National survey-based matrices are annual averages. Most of the data are from three-digit SIC industry estimates from CES series; data for railroads, education, Federal government, State government, and local government are on a two-digit SIC basis. Wage and salary workers in all five of the current matrices discussed in this paper use CES estimates benchmarked to ES-202 data in the spring of 1981. These CES data will be published in August 1981 as Supplement to Employment and Earnings Revised Establishment Data.

In some cases, detailed industries are disaggregated from CES series that were combinations of two or more three-digit SIC industries. In these cases, ES-202 data for 1978 were used to disaggregate the 1978 CES data and ES-202 data for 1979 were used to disaggregate the 1979 and 1980 CES data. When the 1980 ES-202 data become available, they will be used to disaggregate the 1980 CES data, where necessary, for the 1980-II matrix. The ES-202 data for 1978 will be published in the fall of 1981 by the National Technical Information Service (NTIS) and comparable data for 1979 will be published by NTIS in early 1982.

In a few cases--agriculture, forestry, and fishing and private households--industry employment controls were obtained from the CPS. These data are published each year in the January issue of Employment and Earnings following the reference year.

1978 Matrices

1978-II Matrix. The 1978-II matrix included data from Occupational Employment Statistics (OES) surveys on wage and salary worker staffing patterns in State government and local government collected in 1975 (no later data were available); transportation, communications, and public utilities industries collected in 1975 and 1976; trade industries, Federal government, hospitals, and railroads collected in 1976; manufacturing industries collected in 1977; and nonmanufacturing industries collected in 1978.

A combined data file of all the OES survey staffing patterns within the scope of the 1978-II matrix was produced and benchmarked to the 1978 industry controls. This benchmarking step was necessary for two reasons: (1) OES survey data represent observations taken in the spring (second quarter) of the survey year, and (2) the combined OES survey file represents observations in different years; benchmarking theoretically unifies the data to a single year. Because of the differences that can occur as a result of benchmarking to annual averages for a single year, different values for any single occupation/industry cell are usually recorded in the matrix and in the actual OES survey. Wage and salary worker staffing patterns for the nonsurveyed industries--agriculture, forestry, and fishing; education; and private households--which were developed from the Census-based matrix and the CPS were also inputed to this combined data file. Details of the development of the estimates for the nonsurveyed sectors are given in a later section of this paper.

Data on employment for some detailed occupations in the OES survey-based matrix are not collected in some OES surveys, generally because employment is believed to be too small to develop reliable survey estimates. Employment in such occupations, however, is included in a broader category in the OES survey, generally in a residual occupation such as "all other professional workers." For many of these occupational cells, a procedure was developed to disaggregate an employment estimate from the appropriate OES survey data based on employment for a similar occupation/industry cell in the Census-based matrix. 1/ For some occupations included in some OES surveys, however, no procedure was believed to be adequate to disaggregate data for industries in which the occupation was not included in the survey. In such cases, available OES survey data were collapsed into the appropriate residual category in the OES survey-based matrix.

In some cases, two or more detailed survey occupations were collapsed into a single occupation that had a Census-based matrix equivalent. In these cases, sufficient information or knowledge was lacking on which to make employment estimates for cells that had not been surveyed and for which analysts felt there should be employment. For other occupations, collapsing survey data to the comparable Census-based matrix occupations enabled analysts to dissaggregate employment estimates from the survey-based matrix residuals. In this manner, detailed employment information for a number of specialized kinds of compositors, collected only in the printing industry, was suppressed to the broad title of compositors, which was then disaggregated from the residual all other crafts workers for the missing cells. 2/

Once the wage and salary worker portion of the matrix had been developed, the matrix was listed off in two forms: industry by occupation and occupation by industry (transposed matrix). Staff analysts examined the data to identify cells that were inconsistent with their knowledge about an industry or an occupation. The analysis concentrated on occupation/industry cells for which employment estimates were developed by disaggregation procedures.

For some occupations, analysts who reviewed the matrix believed that employment did exist in industries that showed no employment and recommended that employment be added for these matrix cells. To implement these recommendations necessitated further disaggregation of survey-based matrix residuals. Frequently, more than one occupation had to be disaggregated from the same residual to account for the recommendations. In these cases, three policies were generally followed before the changes in the matrix were made. (1) If the sum of the recommended changes did not exceed the appropriate residual, the changes were accepted. (2) If the sum of the recommended changes did exceed the appropriate residual, the recommendations were prorated so that each cell recommended for change received a portion of the residual. (3) If the designated residual contained no employment, updates were disallowed. One notable exception was made to the latter procedure for data processing machine mechanics. For this occupation, employment estimates were disaggregated, to the limits of the residuals, from all other mechanics, all other engineering technicians, and all other technicians, because it was believed that these workers could have been included in all three categories in the OES surveys.

A very detailed procedure was followed to review all update recommendations received from the analytical staff. Recommendations that were accepted were incorporated manually into the matrix. Appropriate residuals were manually adjusted. A total of 4,776 manual updates were made (including updates to residuals). Most updates (about two-thirds) were less than 50 persons in size. 3/

The final step in developing the current employment estimates was to add the separately developed estimates of self-employed persons and unpaid family workers to the updated matrix by detailed occupation at the total all industries level. Details of the methods used to develop these estimates are contained in a later section of this paper.

1978-III Matrix. This matrix and the 1979-II have the same staffing patterns. The detailed occupational employment values are different only because of the different industry controls used in the two years. A detailed explanation of the development of the staffing patterns for the 1978-III matrix is given below in the section discussing the 1979-II matrix.

1979 Matrices

1979-I Matrix. This matrix was developed by first replacing the detailed wage and salary worker occupational employment data for the nonsurveyed sectors with 1979 estimates and then applying the 1979 industry controls to those industries in the 1978-II matrix where wage and salary worker staffing patterns were based on OES survey data. Detailed occupational employment estimates of self-employed persons and unpaid family workers were prepared for 1979. Because the 1979-II matrix was prepared immediately after the 1979-I matrix, the 1979-I was not used for any substanative analysis.

1979-II Matrix. This matrix, which has the same staffing patterns as the 1978-III matrix, includes data from OES surveys of hospitals and railroads collected in 1976 (no later data were available), manufacturing industries and Federal government collected in 1977, nonmanufacturing industries collected in 1978, and balance of nonmanufacturing industries collected in 1979. 4/ Balance of nonmanufacturing was a new designation in 1979, resulting from the combination of surveys, some of which had been conducted in 1975 and others in 1976. Included are transportation, communication, and public utilities; wholesale and retail trade; State government; and local government. Although a survey of employment in educational services establishments was conducted for the first time in 1979, summary data were not available at the time that matrix production began. Consequently, employment estimates for education were developed at the National level from secondary sources, as explained in a later section of this paper.

Estimates from the 1977 and 1978 OES surveys, along with estimates from the 1975 and 1976 OES surveys, had previously been used to build the 1978-II National survey-based matrix. The simplest method of producing the 1979-II matrix was to replace the 1975 and 1976 data with 1979 data for the same industries, leaving the 1977 and 1978 surveyed industry staffing patterns intact. Twenty-four new occupations, 12 of which were in the education survey, that were added for the 1979 round of surveys, were collapsed back to the appropriate survey occupations that appeared in the 1975 and 1976 rounds. In order to duplicate the matrix parameter file, these collapses were done on an industry by industry basis. The application of 1979 industry annual averages from the CES benchmarked all sectors to 1979 employment.

Since the 1978-II matrix that was used in this procedure had already been updated, only the new 1979 estimates were reviewed and updated. The basis for these updates to the new survey data was the updates for the same cells in the 1978-II matrix. Similar values were used, to the limit of the appropriate residuals. Manual calculations of the affected residuals were incorporated also.

Employment estimates for 1979 for the nonsurveyed sectors of agriculture, forestry, and fishing, education, and private households were developed and added. Occupational employment estimates for self-employed persons and unpaid family workers at the all industries level (the same as in the 1979-I matrix) were added to the matrix.

The wage and salary worker portion of this 1979-II matrix for OES survey covered industries was benchmarked to 1978 annual average industry controls from the CES to produce the 1978-III matrix. Nonsurveyed sectors and self-employed persons and unpaid family workers for 1978 were added. The 1978-III matrix became the base year for the 1990 projected matrix.

1980 Matrix

1980-I Matrix. As for the 1979-I matrix, the 1980-I matrix was developed by replacing the detailed occupational employment data for the nonsurveyed sectors of agriculture, forestry, fishing, education, and private households with 1980 employment estimates that had been developed separately from CPS data. The 1980 annual average industry controls from the CES for wage and salary workers were used to benchmark the staffing patterns from the 1979-II matrix to preliminary 1980 staffing patterns. Detailed 1980 occupational employment estimates of self-employed persons and unpaid family workers, developed separately, were added. Thus, the wage and salary worker staffing patterns in the 1978-III, 1979-II, and 1980-I matrices are the same, having been based on the same set of OES survey rounds.

Employment estimates from the 1980-I matrix will be used in the 1982-83 edition of the Occupational Outlook Handbook.

Nonsurveyed Sectors

Occupational employment estimates within industry sectors not covered by OES survey data--agriculture, forestry, and fishing; education; and private households--were developed at the 2-digit industry level and incorporated into the matrix estimating system as data files, just as if they had been surveyed. 5/ The primary inputs in developing these estimates were the CPS and the 1978 National Census-based matrix.

Agriculture. Staffing patterns for agriculture, forestry, and fishing are based on patterns for private wage and salary workers in the Census-based matrix and the CPS. Using the private wage and salary worker patterns eliminated the double-counting of Federal, State, and local government workers employed in these industries, who were already counted in the detailed government industries.

Data from the 1978 Census-based matrix industry, agricultural production, was on a 1967 SIC basis. To use these data in the OES survey-based matrix, which is on a 1972 SIC basis, the Census-based matrix data was divided into the two detailed survey-based matrix industries agricultural production, crops, and agricultural production, livestock. This distribution was made on a 70/30 basis, as a result of discussions held with officials of the Department of Agriculture. All survey-based matrices for the years 1978-1980 reflect this percentage distribution. The staffing pattern in the 1978 Census-based matrix industry, agricultural production, was used for both OES survey-based matrix industries, except for an adjustment to the total employment of athletes in the two survey-based matrix industries to reflect the 80 percent of total athletes in agriculture in the Census-based matrix who were assumed to be horse trainers in the survey-based matrix industry, agricultural production, livestock. An 80/20 adjustment also was made to the control value from the Census-based matrix value for veterinarians to reflect the greater proportion of these workers who would be expected to be found in agricultural production, livestock. After these adjustments, all other cells were forced to the control totals from the CPS for farm workers and for total wage and salary workers for all detailed agriculture, forestry, and fishing industries.

Educational Services. Occupational employment estimates in the educational services sector were based on the 1978 Census-based matrix staffing pattern for all wage and salary workers, including private industry and Federal, State, and local government workers. 6/ Government workers were included in this industry because of their significance to total education employment and because of the need to generate employment estimates for education separate from the much larger employment estimates for the government sectors. In these matrices, education workers are not included in the estimates for State and local government. A few further disaggregations of occupations were made based on limited data from one State's OES survey in 1976. 7/ These occupations were refined using ratios from that survey and included college teachers, graduate students, and extension service specialists from college and university teachers; librarians and audio-visual specialists from librarians; three kinds of file clerks; four kinds of food service workers; and a number of other detailed survey occupations, a complete list of which is shown below.

Census-Based Matrix Occ.	Survey-Based Matrix Occ.	SBM Code
Biological scientists	Biological scientists	10040601
	Medical scientists	10040602
Eng. and sci. tech., nec	All other engineering techs.	10081898
	Science technicians	10081899
Therapists	Speech and hearing clinicians	10101803
	Physical therapists	10101804
	All other therapists	10101810
Technicians, nec	All other technicians	10141404
	Technical assts., library	10141405
Teachers, college & univ.	Teachers, voc. ed. & train.	10202001
	Teachers, college	10202002
	Graduate assistants	10202003
	Extension service specialists	10202004
Librarians	Librarians	10242401
	Audio-visual specialists	10242402
Sales workers	Sales clerks	30001802
	Sales reps., agents	30001899
Computer operators	Computer operators	40040601
	Peripheral equip. operators	40040602
Bookkeepers	Accounting clerks	40060601
	Bookkeepers, hand	40060603
File clerks	File clerks	40062601
	Personnel clerks	40062602
	Admissions evaluators	40061603
Receptionists	Receptionists	40064802
	Switchbd. ops./receptionists	40064803
Misc. clerical workers	Mail clerks	40063402
	General clerks, office	40066812
	All other off. clerical wkrs.	40066898
Foremen, nec	Supervisors, nonworking	50040003

	Supervisors, nonwkg., service	70200001
Craft workers, nec	Maint. repairers, gen. util.	50144821
	All other skilled workers	50144899
Cooks	Cooks, short order	70040802
	Cooks, institutional	70040804
Waiters and waitresses	Hosts and hostesses, rest.	70041601
	Waiters and waitresses	70041602
Food service workers, nec	Kitchen helpers	70041802
	Fd. prep. wkrs., fast food	70041804
	Pantry, sandwich prep. wk.	70041805
	All other fd. service wkrs.	70041899
Misc. laborers	Helpers, trades	80002833
	All other unskilled wkrs.	80002899

Based on information available from the National Center for Educational Statistics (NCES) and other secondary sources, five cells were fixed in the 1978 matrices: Elementary school teachers; technical assistants, library; janitors; secretaries; and typists. All other cells in the educational services sector were forced to the 1978 industry control. The 1978 pattern was used to developed the 1979 and 1980 estimates.

Private Households. For each year's OES survey-based matrix, the CPS annual average employment for each of the five detailed private household worker occupations was used as a fixed cell. The remaining occupations in the private household industry were developed by forcing the remainder of the CPS annual average industry employment into a distribution based on the private household industry in the 1978 Census-based matrix.

With the addition of the nonsurveyed sectors to the surveyed sectors, total wage and salary worker matrices were produced, by occupation and industry.

Self-Employed Persons and Unpaid Family Workers

Estimates of occupational employment of self-employed persons and unpaid family workers were developed only at the total all industries level, rather than by detailed industry as in the Census-based matrix, because the development of such data would have produced very unreliable estimates. The general procedure was to develop employment estimates of self-employed persons and unpaid family workers for each detailed Census-based matrix occupation and then distribute the employment to related OES survey-based matrix occupations.

The 1978 Census-based matrix was the primary source of data used to develop estimates of self-employed persons and unpaid family workers. Data in the 1978 Census-based matrix, however, were modified for some occupations where the relationship of self-employed persons and unpaid family workers to total employment were out of line with trends over the 1971-78 period, based on CPS data. To develop estimates for 1979 and 1980, trends in the relationship of self-employed persons and unpaid family workers to total employment over the 1971-80 period were used to modify the 1978 ratios. These ratios were applied to CPS total employment for each occupation in these years to develop estimates of self-employed persons and unpaid family workers. The resulting data were forced to agree with the CPS 1979 and 1980 annual average employment estimates for each class of worker.

The employment totals for self-employed persons and unpaid family workers in each Census-based matrix occupation were distributed to OES survey-based matrix occupations. A list of OES survey-based matrix occupations that were related to the 400 Census-based matrix occupations was developed. Analysts studied these relationships and distributed the Census-based matrix occupational control totals to OES survey-based matrix occupations. Some occupations were a one-for-one match. For other occupations, however, a distribution was made based on limited information. One of the following procedures was used by individuals making the estimates for each occupation: (1) The entire Census-based matrix employment of self-employed persons and unpaid family workers was distributed to related OES survey-based matrix occupations based on the distribution of wage and salary workers in those ocupations in the OES survey-based matrix; (2) The entire Census-based matrix employment for each class of worker was distributed on a judgment basis to selected OES survey-based matrix occupations to which it was related; (3) The entire Census-based matrix employment of self-employed persons and unpaid family workers was placed in an appropriate OES survey-based matrix occupational residual; and (4) Any combination of the above that made sense in terms of the analyst's knowledge of the specific occupation(s).

In using these procedures, the analysis was focused on the 1978 data and then similar procedures were used for 1979 and 1980 for each occupation. In general, the most common procedure followed was to distribute the control totals for self-employed persons and unpaid family workers in the Census-based matrix by the distribution of wage and salary workers in related OES survey-based matrix occupations. Adjustments were made in cases where this distribution did not make analytical sense. For example, no estimate was made for self-employed judges or self-employed claims takers for unemployment insurance benefits, even if the Census-based matrix occupation where these workers were included had some self-employed persons.

Summary Tables

After employment estimates of self-employed persons and unpaid family workers were developed, they were added to the wage and salary worker employment estimates to produce total employment by occupation at the total all industries level.

Projected Year Matrices (1990)

The 1990 occupational projections were developed as part of the Bureau's economic and employment projections efforts, which include projections of the labor force, gross national product, productivity, industry output, and industry employment. The Bureau developed three alternative 1990 projections, each based on different assumptions concerning such factors as labor force growth, defense expenditures, unemployment rate, and productivity trends. The assumptions and related projections are published in the August 1981 issue of the *Monthly Labor Review*.

The basic procedure used to develop occupational projections was to apply projected staffing patterns for each industry in the OES survey-based matrix to projected wage and salary worker employment in the related industry. Separate totals for self-employed persons and unpaid family workers were projected for each occupation. These totals were added to the projected wage and salary worker totals for the occupation to develop the total employment projection by occupation. Projections were developed for each of the three alternative scenarios, but the same staffing patterns of industries were used in each alternative. The following detailed procedures were used to develop the occupational projections.

Industry Controls

The Bureau's model produces projections for 156 industry groups. These projections were disaggregated to the 378 industries included in the OES survey-based matrix. In general, projections of industry employment for all CES published series developed through regression analysis were used to disaggregate employment in the 156 sectors. Industry employment projections for the unpublished CES series were developed by disaggregation of the appropriate projected CES series on the basis of trends in ES-202 data.

Occupational Staffing Patterns

Surveyed Sectors. In projecting occupational staffing patterns for industries in previous projection cycles, Decennial Census data were extrapolated into the future based on decade to decade changes. Considerable analysis and review identified the factors that caused changes in staffing patterns. The analysis resulted in many changes to the mechanically developed extrapolated ratios. However, a review of the 1975 occupational projections, done just prior to the development of the most recent 1990 projections, indicated that the major cause of errors in the projections was incorrect projection of occupational ratios. An intensive effort was devoted to research on methods of projecting OES survey-based matrix staffing patterns. 6/

In general, the research tested the merits of a variety of extrapolation techniques. In these tests, use of current staffing patterns in the projected years generally produced better results, on the average, than any extrapolation technique. However, for large occupations that were not affected by any problems related to changes in industry or occupational definitions, the exponential extrapolation technique generally outperformed the constant ratio method. Since the tests were performed on data covering a short period of time and the exponential method worked well for large occupations representing a very significant proportion of employment, this technique was used where possible. The research also indicated that ratios developed through mechanical means must undergo intensive analytical review.

The first step in developing the projected staffing patterns for the OES survey-based matrix was to project trends in OES survey data from the last two OES survey rounds for each industry. Unfortunately, because of changes between survey rounds in industry definitions (change from the 1967 SIC to the 1972 SIC), occupational definitions, survey forms, and geographical coverage, many difficulties were encountered in this process.

Periodically, the SIC system, used as the basis for OES survey industry definitions, is changed. Such a change occurred between the OES survey round providing data for the current 1978 and 1980 matrices and the OES survey round immediately preceeding that affected several industries. As a result, trends could not be developed because the data were not comparable. In these cases, ratios were held constant at 1978 levels for the initial 1990 projected matrix. Trends were extrapolated only in industries in which 95 percent or more of employment included in the 1972 SIC industry definition was also included in the same industry in the 1967 SIC industry definition.

Between the last two survey rounds, definitions were changed for several OES survey occupational categories. Some new occupations were added in the last survey round. With only one observation, trends could not be developed for these new occupations. Additionally, the occupational category that probably included the occupation in the previous round could not be projected because of inconsistent occupational content. Similar situations resulted when occupations were dropped or combined with other occupations in the OES survey.

Even though the OES survey has been conducted since 1971 as a Federal-State cooperative program, all States do not participate in the program and the number of States in each OES survey round has varied. Beginning with the 1977 OES survey, the BLS surveyed the nonparticipating States as a whole and National data became available. 9/ Because National data were not available for both of the last two survey rounds in any industry, data from States that participated in both of the last two OES surveys for each industry were summed and used as a proxy for National data. The number of States providing data used in developing trends to 1990 was as follows for each survey round: 1974 and 1977 manufacturing, 27; 1975 and 1978 nonmanufacturing, 29; and 1973 and 1976 trade, 19. The development of trends, therefore, excluded some States that may have had significant employment in a specific occupation. In future projection rounds, this weakness will be eliminated; National data will become available for two points in time beginning with the 1980 OES survey, except for education and railroads.

To overcome the problems identified above concerning the comparability of OES survey data in the last two OES survey rounds, only those occupations with consistent definitions that were found in industries with consistent SIC content were projected through the exponential extrapolation technique to 1990. The projected trends in survey occupations were related to appropriate OES survey-based matrix occupations. Adjustments were made to these cells and any other cells in the matrix by analysts who reviewed the data for all industries. The analysis was concentrated, however, on industries that employed over 100,000 workers. Cells that were not projected were held constant in 1990 at the 1978 levels. An iteration procedure forced the distribution patterns in each industry to add to 100 percent. These patterns became the initial 1990 projected staffing patterns.

The initial projected staffing pattern in each industry was applied to projected industry employment totals for wage and salary workers to develop the preliminary 1990 occupational projections. These projections were analyzed in detail over a six month period, based on studies of occupations and industries conducted during preparation of the Occupational Outlook Handbook. Factors considered by analysts included changes in production methods, technological changes affecting occupational mix, changes in product mix of industries, changes in average size of establishments in industries, and other economic factors affecting specific occupations.

In addition, some occupations were projected independently of the matrix based on the relationship of the occupation to more closely associated variables. For example, projections of elementary school teachers were based on estimates of the school age population and pupil-teacher ratios. Projections developed in this manner were used in the matrix and adjustments in the ratios for other occupations were made when necessary.

During the analysis, relationships were established between occupations in the Census-based matrix and the OES survey-based matrix to obtain the benefit of a longer time series. Based on all the analyses described above, changes were made in the initial projected OES survey-based matrix and an iteration procedure assured that the staffing pattern in each industry added to 100 percent. The resulting ratios were applied to total projected employment of wage and salary workers in each industry to develop the final occupational projections of wage and salary workers.

Nonsurveyed Sectors. The initial projected 1990 occupational ratios for the agriculture, forestry, and fishing, education, and private households industries were taken directly from the 1990 Census-based matrix developed by the Bureau for 1978-90. The ratios were analysed based on CPS data that became available after the Census-based matrix was developed, and a few ratios were adjusted. The occupational distribution in the Census-based matrix was converted to the OES survey-based matrix distribution in the same way described above for the current year matrices.

The projected ratios were applied to the 1990 industry projections for the appropriate industries. The results were reviewed in detail. Changes in the staffing patterns resulted from this review were incorporated in the final matrix.

Self-Employed Persons and Unpaid Family Workers. Based on an analysis of the trends in the 1978-90 Census-based matrix and the 1971-80 CPS data on the ratio of self-employed persons and unpaid family workers to total employment in each occupation, estimates were developed of the percentage of each of these two classes of workers to total employment in each Census-based matrix occupation. These ratios were applied to projected 1990 total employment for each Census-based matrix occupation. The summed result was compared to the 1990 control totals for these two classes of workers, which had been independently projected as part of the Bureau's economic model. Minor adjustments forced the ratios to 100 percent and the individual estimates to the control totals.

Using the methods already indicated, the Census-based matrix occupational estimates were disaggregated by Handbook analysts to the full list of survey-based matrix occupations. These were reviewed for consistency with information developed in the course of other occupational research and appropriate changes were made.

Total Occupational Employment. To develop total employment projections by occupation, projections of wage and salary workers in the surveyed and nonsurveyed sectors was added to the projected totals of self-employed persons and unpaid family workers. Unlike previous projections of total National employment, the totals in the OES survey-based matrix represent the number of jobs by occupation, not the number of persons employed by occupation. 10/ These totals are different because one person may have more than one job. The difference between the number of jobs and the number of persons employed in 1990 is estimated at approximately 7 percent.

Footnotes

1/ For a more detailed explanation of these disaggregation techniques, see "Development of the State OES Survey-Based Matrix," OES Matrix/Projections Memo No. 12, September 10, 1979. Approximately 4 percent of total occupational employment was developed through disaggregation of residuals.

2/ A total of 1,836 detailed survey occupations were used directly, disaggregated, or collapsed to a final occupational list (after manual updating) containing 1,615 detailed matrix occupations. This same final occupational list was used for all 1978, 1979, and 1980 matrices. These numbers may change in future matrices as the number of OES survey occupations included increases or decreases.

3/ A list of these updates was given to States engaged in developing projections for the interim projections project to use as a guide for updating State matrices. In this list, updates of less that 50 persons were excluded to eliminate possible problems in allocating small numbers among the various States. When these smaller updates were removed from the list, the number of updates dropped to 1,543.

4/ Employment in hospitals was resurveyed in 1980. Employment in railroads has not been surveyed since 1976; there are no immediately plans to resurvey this industry.

5/ Although an OES survey of employment in educational services was conducted in 1979, National data from this survey are not available because 10 States did not participate, one of which was California. Furthermore, a combined estimates file of the 41 States that did participate in the OES education survey was not available in time to use in these first National OES survey-based matrices. Surrogate National estimates, based on data from the 41 States, will be used in the 1980-II matrix.

6/ See ftn. 5.

7/ In 1976, Oklahoma became the first State to collect data on employment in educational services. No other data on employment in education were available at the time the matrices discussed in this paper were developed.

8/ For a more detailed explanation, see "Projected Occupational Staffing Patterns of Industries," BLS technical paper, April 1981.

9/ Funds to do this work were provided to the Bureau by the National Science Foundation.

10/ Wage and salary workers in agriculture, private households, and education were only counted once, even if they held more than one job because the CPS was the source of data on employment in these industries. Similarly, self-employed persons and unpaid family workers are counted only once in their primary job.

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16. Abstract (Limit: 200 words)

This report, one of a series of reports concerning exposure assessment, describes methods for estimating the sizes of populations potentially exposed to chemical substances. Five categories of exposed populations are covered: (1) populations exposed to chemicals in the ambient environment, (2) workers, (3) populations exposed through ingestion of chemicals in food, (4) users of consumer products, and (5) populations exposed through ingesting chemicals in drinking water. The report contains general data on populations from governmental agencies such as the U.S. Bureau of Census, U.S. Department of Labor, U.S. Department of Agriculture, and EPA's Office of Drinking Water. It also contains step-by-step methods for locating and using data to enumerate each subpopulation identified as potentially exposed to toxic chemicals. Appendix A contains sample calculations illustrating the methods presented in the text. Appendix B is OSHA's Industry-Occupation (I-O) Matrix, described in Section 3 of the report.

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